GM47r5/GM48r5
Integrator's Manual

Sony Ericsson

CE

The GM47r5 described in this manual conforms to the Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC with requirements covering EMC directive 89/336/EEC and Low Voltage directive 73/23/EEC. The product fulfils the requirements according to 3GPP TS 51.010-1, EN 301 489-7 and EN60950.

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The GM48R5 described in this manual conforms to the Federal Communications Commission, FCC Rules Parts 22.901d and 24 E and PTCRB NAPRD.03_TC version:
V.2.7.2, 3GPP TS 51.010 Version: 3GPP TS 51.010-1 V.5.6.0

SAR statement: This product is intended to be used with the antenna or other radiating element at least 20 cm away from any part of the human body.

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1 Introduction

1.1 Target Users

The GM47r5 and GM48r5 radio devices are designed to be integrated into machine-to-machine or man-to-machine communications applications. They are intended to be used by manufacturers, system integrators, applications developers and developers of wireless communications equipment.

1.2 Prerequisites

It is assumed that the person integrating the radio device into an application has a basic understanding of the following:

- GSM networking;
- Wireless communication and antennas (aerials);
- AT commands;
- ITU-T standard V.24/V.28;
- Micro controllers and programming;
- Electronic hardware design.

1.3 Manual Structure

The manual is composed of three parts:

Part 1- Overview

This section provides a broad overview of the GM47r5/GM48r5 family and includes a list of abbreviations used in the manual.

Part 2 - Integrating the Radio Device

This section describes each of the signals available on the GM47r5/GM48r5 radio devices, along with mechanical information. The section also provides you with design guidelines and explains what is needed to commercialise an application from a regulatory point of view.

Part 3 - Developer's Kit

This section lists the contents of the Developer's Kit and provides the information to setup and use the equipment.

2 GM47r5/GM48r5 Radio Devices

2.1 About the GM47r5/GM48r5 Family

Two radio devices make up the family; GM47r5 and GM48r5, for use in the E-GSM900/GSM1800 and GSM850/GSM1900 bands respectively.

Note! This manual refers to the GM47r5 and GM48r5 as radio devices. If there is a difference in the functionality of the radio devices the GM47r5 and GM48r5 information will be listed separately.

The products belong to a new generation of Sony Ericsson radio devices, and are intended to be used in machine-to-machine applications and man-to-machine applications. They are used when there is a need to send and receive data (by SMS, CSD, HSCSD, or GPRS), and make voice calls over the GSM network.

The radio devices can either have applications embedded onto them or they can be used as the engine in an application created by the customer. The radio device can send and receive data when a script is executed, the script can be run internally from the radio device itself or from a micro-controller. A typical application, involves a micro-controller and a radio device, in which the micro-controller sends AT commands to the radio device via an RS232 communications link.

2.2 Radio Devices in a Communication System

Figures 2.1 and 2.2 illustrate the main blocks of a wireless communication system using the radio device. Figure 2.1 shows the communication system when the script is embedded on the radio device and figure 2.2 shows the communication system when a micro-controller is used. They also show the communication principles of the system and the interface between the radio device and the application. The definitions in the figures, as used elsewhere in this manual, are in accordance with the recommendations of GSM 07.07.

- The MS (mobile station) represents the radio device and SIM card. The radio device excluding SIM card, is known as the ME (mobile equipment).

- The DTE (data terminal equipment) is the controlling application. This can be either an external host or an internal embedded application.
- The DCE (data circuit terminating equipment) is the serial communication interface of the MS.

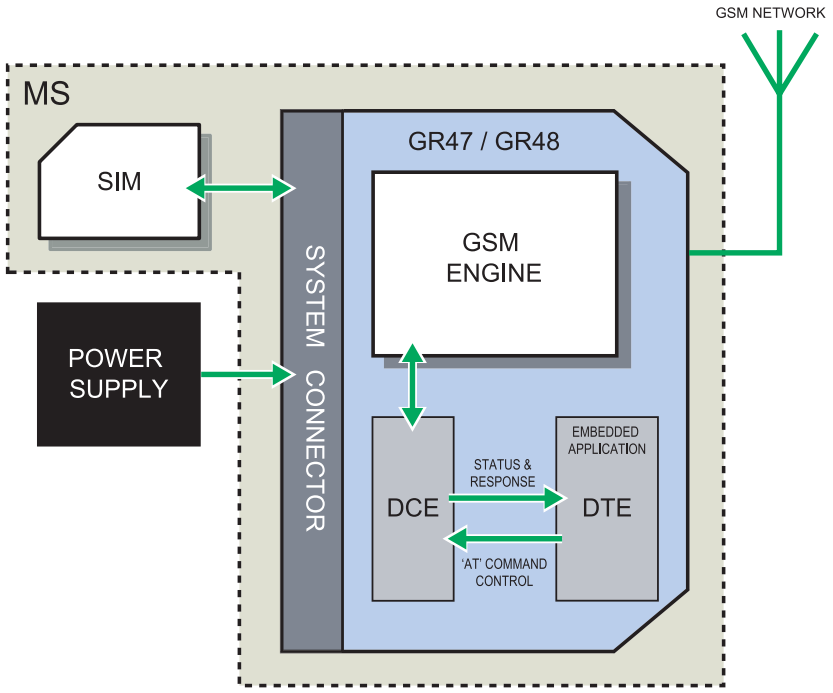

Figure 2.1 Main Blocks in a Wireless System (embedded application)

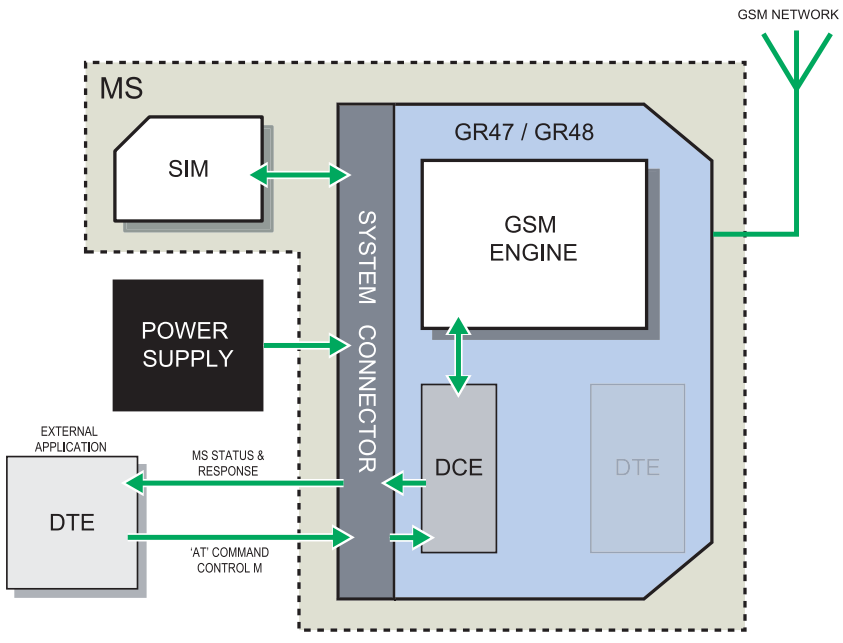

Figure 2.2 Main Blocks in a Wireless System (external micro-controller)

In accordance with the recommendations of ITU-T (International Telecommunication Union - Telecommunications Standardisation Sector) V.24, the TE communicates with the MS over a serial interface.

The functions of the radio device follow the recommendations provided by ETSI (European Telecommunications Standards Institute) and ITU-T.

ETSI specifies a set of AT commands for controlling the GSM element of the radio device; these commands are supplemented by Sony Ericsson specific commands.

To find out how to work with AT commands, see the AT Commands Manual.

2.3 Features

The radio device performs a set of telecom services (TS) according to GSM standard phase 2+, ETSI and ITU-T. The functions of the radio device are implemented by issuing AT commands over a serial interface.

2.3.1 Types of Mobile Station

GM47r5 and GM48r5 are dual band mobile stations with the characteristics shown in the tables below.

GM47r5	*E-GSM 900*	*GSM 1800*
Frequency Range (MHz)	TX: 880-915 RX: 925-960	TX: 1710-1785 RX: 1805-1880
Channel spacing	200 kHz	200 kHz
Number of channels	174 carriers *8 time slots	374 carriers *8 time slots
Modulation	GMSK	GMSK
TX phase accuracy	< 5º RMS phase error (burst)	< 5º RMS phase error (burst)
Duplex spacing	45 MHz	95 MHz
Receiver sensitivity at antenna connector	< –102 dBm	< –102 dBm
Transmitter output power at antenna connector	Class 4 2 W (33 dBm)	Class 1 1 W (30 dBm)
Automatic hand-over between E-GSM 900 and GSM 1800		

GM48r5	*GSM 850*	*GSM 1900*
Frequency Range (MHz)	TX: 824-849 RX: 869-894	TX: 1850-1910 RX: 1930-1990
Channel spacing	200 kHz	200 kHz
Number of channels	124 carriers *8 time slots	299 carriers *8 time slots
Modulation	GMSK	GMSK
TX Phase Accuracy	< 5º RMS phase error (burst)	< 5º RMS phase error (burst)
Duplex spacing	45 MHz	80 MHz
Receiver sensitivity at antenna connector	< –102 dBm	< –102 dBm
Transmitter output power at antenna connector	Class 4 2W (33 dBm)	Class 1 1 W (30 dBm)
Automatic hand-over between GSM 850 and GSM 1900		

2.3.2 Short Message Service

The radio device supports the following SMS services:

- Sending; MO (mobile-originated) with both PDU (protocol data unit) and text mode supported.
- Receiving; MT (mobile-terminated) with both PDU and text mode supported.
- CBM (cell broadcast message); a service in which a message is sent to all subscribers located in one or more specific cells in the GSM network (for example, traffic reports).
- SMS STATUS REPORT according to GSM 03.40.

The maximum length of an SMS message is 160 characters when using
7-bit encoding. For 8-bit data, the maximum length is 140 characters. The radio device supports up to six concatenated messages to extend this function. Concatenation is disabled if CNMI 3,2 is set (See the AT Commands Manual for further details).

2.3.3 Voice Calls

The radio device offers the capability of MO (mobile originated) and MT (mobile terminated) voice calls, as well as supporting

emergency calls. Multiparty, call waiting and call divert features are available. Some of these features are network-operator specific.

For the inter-connection of audio, the radio device offers both single ended and balanced analogue input and output lines. Direct interface to the digital PCM (pulse code modulation) bus used within the radio device is available, thus by-passing the internal analogue circuitry.

The radio devices support HR, FR and EFR vocoders. The GM48R5 also supports the Adaptive Multi Rate (AMR) type of vocoder.

2.3.4 Data

The radio device supports the following data protocols:

- GPRS (General Packet Radio Service)
  The radio devices are Class B terminals. The radio devices are GPRS 4+1 enabled, which are capable of receiving at a maximum of four timeslots per frame (down link), and transmitting in one timeslot per frame (up link).
- CSD (Circuit Switched Data)
  The radio devices are capable of establishing a CSD communication at 9.6 kbps.
- HSCSD (High Speed Circuit Switched Data).
  The radio devices support HSCSD communication, with one timeslot per frame capacity in the up link and two timeslots per frame capacity in the down link (2+1).

2.3.5 SIM Card

An external SIM card with 3 V or 5 V technology, can be connected to the radio device via its 60-pin system connector. The unit does not need any external components to enable this.

2.3.6 Power Consumption

		Idle Mode	*Transmit/Operation*
GSM 850 and E-GSM 900	Voice/CSD	< 5 mA	< 250 mA (< 2 A peak)
	Data (GPRS 4+1)	< 5 mA	< 350 mA (< 2 A peak)
GSM 1800 and GSM 1900	Voice/CSD	< 5 mA	< 250 mA (<1.75 A peak)
	Data (GPRS 4+1)	< 5 mA	< 350 mA (<1.75 A peak)

Note! The power consumption during transmission is measured at maximum transmitted power.

2.3.7 Other Features

These include:

- 07.10 multiplexing.
- GPS interoperability.
- SIM application tool kit, class 2 release 96 compliant.
- Embedded application
- On board TCP/IP stack
- AMR (Supported by GM48R5)

2.4 Service and Support

2.4.1 Web Pages

Visit our web site for the following information:

- where to buy radio devices or for recommendations concerning accessories and components;
- the telephone number for customer support in your region;
- FAQs (frequently asked questions).

The web site address is:

http://www.SonyEricsson.com/M2M

2.4.2 Extranet

The extranet contains all of the more in depth documentation, such as AT commands manual, software bulletins, etc. To gain access to the site please contact either your sales person or customer support.

2.4.3 Integrator's Manual

This manual provides you with all of the information you need to integrate the radio device into your application.

2.4.4 AT Commands Manual

The AT Commands Manual provides you with all the AT commands you can use with your radio device. AT commands are in logical groups and contain the command, a description of its functionality and an example of use.

2.4.5 M2*m*power Application Guide

The M2*m*power Application Guide provides you with all the information you need to build an application using the M2*m*power support environment. This manual is supplied as part of the M2*m*power package. There are also a number of application notes which accompany the guide showing how to use specific functionality.

2.4.6 Developer's Kit

Sony Ericsson provides the developer's kit to get you started quickly. The kit includes the necessary hardware required to begin the development of an application. It includes the following:

- GSM radio device, GM47r5 or GM48r5;
- This Integrator's Manual;
- Developer's kit hardware;
- Developer's kit accessories;
- Power supply
- RS232 cable
- Headset
- Antenna.

All the user needs to provide, is a computer or micro-controller and the expertise to use AT commands.

2.5 Precautions

The radio devices are ESD protected up to 4KV contact and 8KV air discharge. It is recommended that you follow electronic device handling precautions when working with any electronic device system to ensure no damage occurs to the host or the radio device. In "Integrating the Radio Device", page 16 you will find more information about safety and product care. Do not exceed the environmental and electrical limits as specified in Technical Data, page 61.

2.6 Customer support contact details

To contact customer support please use the details below.

Customer Support
Sony Ericsson Mobile Communications (UK) Ltd
M2MCom

1 Lakeside Road
Systems Union House
Aerospace Park
Farnborough
Hampshire
UK
GU14 6XP

E mail : M2Msupport.EMEA-APAC@sonyericsson.com
M2Msupport.Americas@sonyericsson.com
M2Minfo@sonyericsson.com

3 Abbreviations

Abbreviation	*Explanations*
AMR	Adaptive Multi Rate
ATMS	Audio to Mobile Station
AFMS	Audio from Mobile Station
CBM	Cell Broadcast Message
CBS	Cell Broadcast Service
CSD	Circuit Switched Data
DCE	Data Circuit Terminating Equipment
DK	Developer's Kit
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi Frequency
EA	Embedded Application
EFR	Enhanced Full Rate
EMC	Electro-Magnetic Compatibility
ETSI	European Telecommunication Standards Institute
FR	Full Rate
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communication
HR	Half Rate
HSCSD	High Speed Circuit Switched Data
IDE	Integrated Development Environment
IP	Internet Protocol
ITU-T	International Telecommunication Union - Telecommunications Standardisation Sector
M2*m*power	Sony Ericsson's powerful support environment
ME	Mobile Equipment
MMCX	Micro Miniature Coax

MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
RF	Radio Frequency
RFU	Reserved for Future Use
RLP	Radio Link Protocol
RTC	Real Time Clock
SDP	Service Discovery Protocol
SIM	Subscriber Identity Module
SMS	Short Message Service
TCP	Transport Control Protocol
UDP	User Datagram Protocol

4 Mechanical Description

4.1 Interface Description

The pictures below show the mechanical design of the radio device along with the positions of the different connectors and mounting holes. The radio device is protected with AISI 304 stainless steel covers that meet the environmental and EMC requirements.

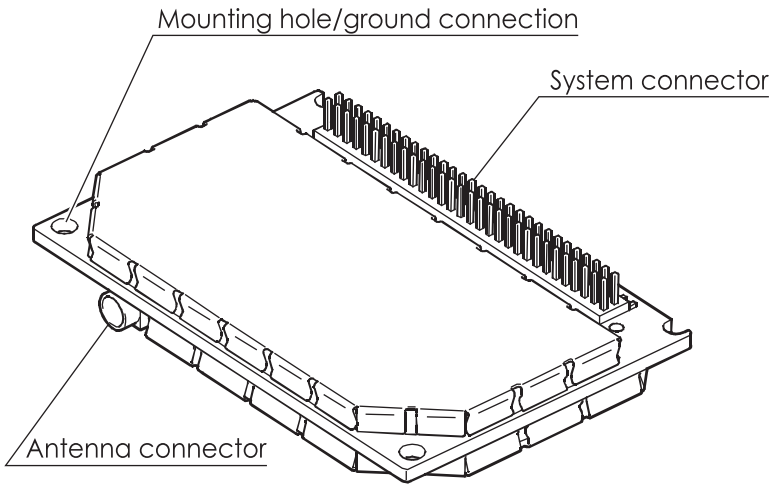

Figure 4.1 Radio Device viewed from below

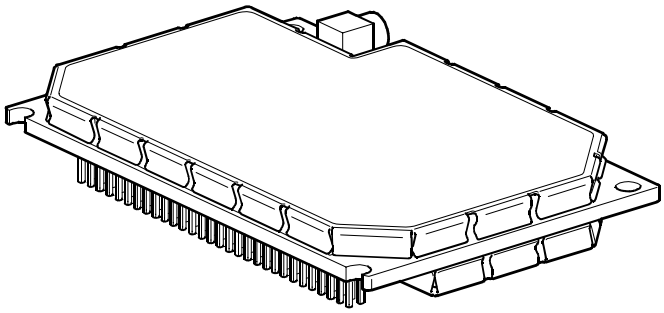

Figure 4.2 Radio Device, viewed from above

Please note the following:

- Mounting holes positioned at the corners make it possible to securely bolt the radio device into your application.

- Keypad, display, microphone, speaker and battery are not part of the radio device.
- The SIM card is mounted in your application, external to the radio device.
- The System Connector is a 60-pin, standard 0.05 in (1.27 mm) pitch type. The pins and their electrical characteristics are described in
  5 System Connector Interface, page 20.
- Information about the Antenna Connector is found in 6 Antenna Connector page 52.

4.2 Physical Dimensions

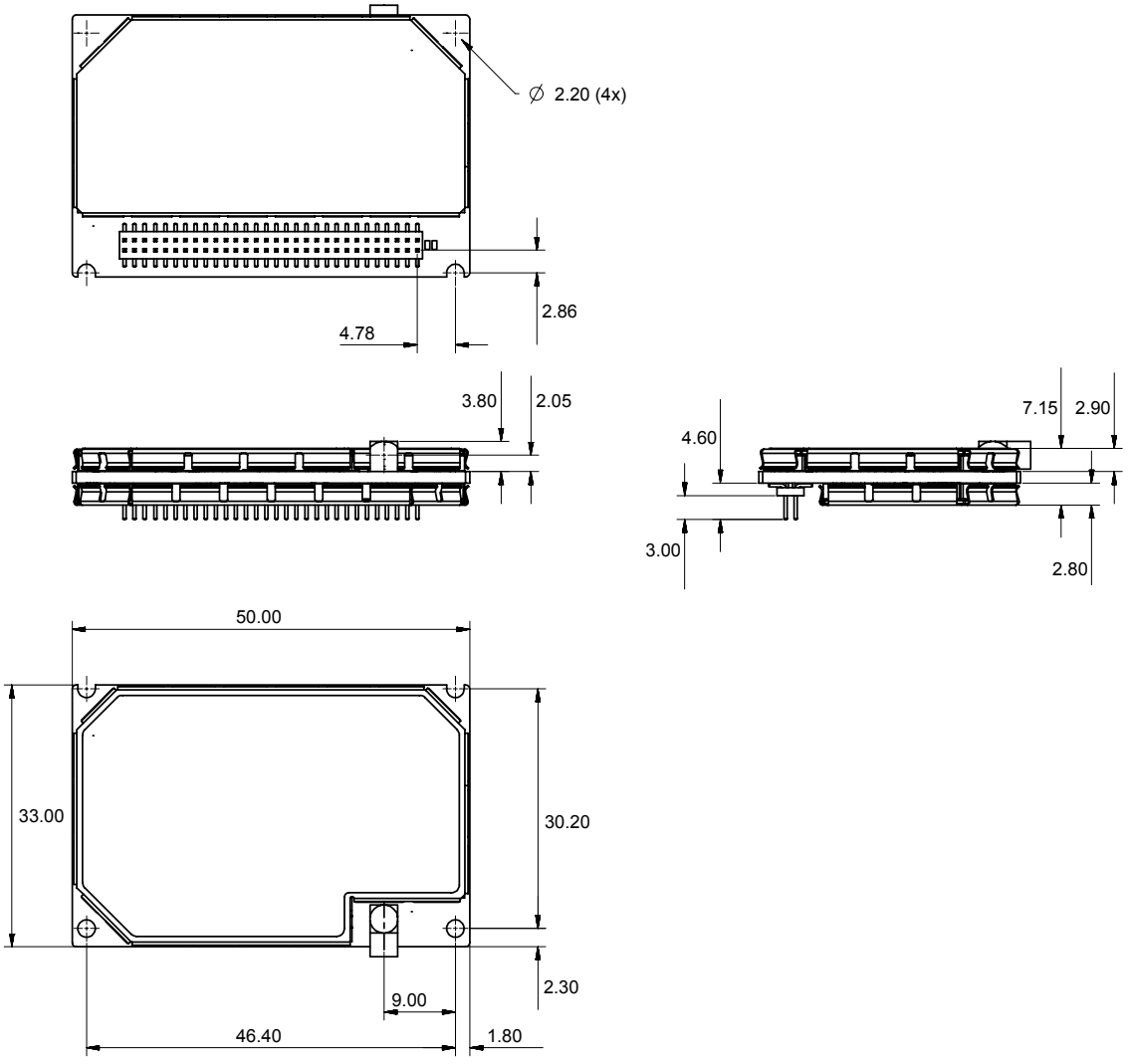

Figure 4.2 Dimensions of the Radio Device

Measurements are given in millimetres. See also Technical Data page 61.

5 System Connector Interface

5.1 Overview

Electrical connections to the radio device (except the antenna), are made through the System Connector Interface. The system connector is a 60pin, standard 0.05 in (1.27 mm) pitch device.

The system connector allows both board-to-board and board-to-cable connections to be made. Use a board-board connector to connect the radio device directly to a PCB, and a board-cable connector to connect the radio device via a cable.

Figure 5.1 below shows the numbering of the connector pins.

A ground connection is provided at the mounting hole next to the RF connector on the radio device as shown below. Connect this ground point to the DGND pins of the radio device by the shortest, low-impedance path possible. The purpose of this connection is to allow any antenna ESD strikes to bypass the radio device's internal ground path.

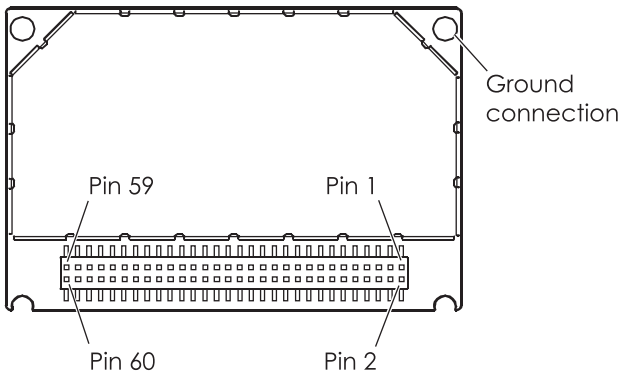

Figure 5.1 Radio Device, viewed from underneath

The following table gives the pin assignments for the system connector interface and a short description for each signal.

Note! Under the heading “Dir” in the table, radio device input and output signals are indicated by the letters I and O respectively.

Pin	*Signal Name*	*Dir*	*Signal Type*	*Description*
1	VCC	-	Supply	Power supply
2	DGND	-	-	Digital ground
3	VCC	-	Supply	Power supply
4	DGND	-	-	Digital ground
5	VCC	-	Supply	Power supply
6	DGND	-	-	Digital ground
7	VCC	-	Supply	Power supply
8	DGND	-	-	Digital ground
9	VCC	-	Supply	Power supply
10	DGND	-	-	Digital ground
11	CHG_IN (RFU)	-	Battery charge power	Battery charging
12	DGND	-	-	Digital ground
13	IO5 ADC4	I/0 I	Digital 2.75V Analogue	General purpose input/output 5 Analogue to digital converter 4
14	ON/OFF	I	Internal pull up, open drain	Turns the radio device on and off.
15	SIMVCC	-	Digital 3 V/5 V	SIM card power supply. Power output from radio device for SIM Card
16	SIMPRESENCE	I	Internal pull up, open drain	SIM Presence A “1” indicates that the SIM is missing; a “0” that it is inserted
17	SIMRST	O	Digital 3 V/5 V	SIM card reset
18	SIMDATA	I/O	Digital 3 V/5 V	SIM card data
19	SIMCLK	O	Digital 3 V/5 V	SIM card clock
20	DAC	O	Analogue	Digital to analogue converter
21	IO1	I/O	Digital 2.75V	General purpose input/output 1
22	IO2 ADC5	I/O I	Digital 2.75V Analogue	General purpose input/output 2 Analogue to digital converter 5
23	IO3	I/O	Digital 2.75V	General purpose input/output 3

24	IO4	I/O	Digital 2.75V	General purpose input/output 4
25	VRTC	I	Supply 1.8V	Supply for real time clock
26	ADC1	I	Analogue	Analogue to digital converter 1
27	ADC2	I	Analogue	Analogue to digital converter 2
28	ADC3	I	Analogue	Analogue to digital converter 3
29	SDA	I/O	2.75V, internal pull up	I^2C data
30	SCL	O	2.75V, internal pull up	I^2C clock
31	BUZZER	O	Digital 2.75V	Buzzer output from radio device
32	OUT3 DSR	O O	Digital 2.75V	General purpose output 3 Data set ready (UART1)
33	LED IO6	O I/O	Digital 2.75V	Flashing LED General purpose I/O 6
34	VIO	O	Power Out 2.75 V	Radio device power indication. VIO is a 2.75 V at 75 mA output supply that can be used to power external circuitry that interfaces to the radio device
35	TX_ON	O	Digital 2.75V	This output indicates when the GSM radio device is going to transmit the burst
36	RI O2	O O	Digital 2.75V	Ring Indicator (UART1) General purpose output 2
37	DTR IN1	I I	Digital 2.75V	Data Terminal Ready (UART1) General purpose input 1
38	DCD O1	O O	Digital 2.75V	Data Carrier Detect (UART1) General purpose output 1
39	RTS IO9	I I/O	Digital 2.75V	Request To Send (UART1) General purpose I/O 9
40	CTS O4	O O	Digital 2.75V	Clear To Send (UART1) General purpose output 4
41	TD	I	Digital 2.75V	Transmitted Data (UART1). Data from DTE (host) to DCE (radio device).

42	RD	O	Digital 2.75V	Received Data (UART1). Data from DCE (radio device) to DTE (host).
43	TD3 I/O7	I I/O	Digital 2.75V	Transmitted data (UART3) General purpose I/O 7
44	RD3 I/O8	O I/O	Digital 2.75V	Received data (UART3) General purpose I/O 8
45	TD2	I	Digital 2.75V	Transmitted data (UART2). Used for flashing the memory.
46	RD2	O	Digital 2.75V	Received data (UART2). Used for flashing the memory.
47	PCMULD	I	Digital 2.75V	DSP PCM digital audio input
48	PCMDLD	O	Digital 2.75V	DSP PCM digital audio output
49	PCMO	O	Digital 2.75V	Codec PCM digital audio output
50	PCMI	I	Digital 2.75V	Codec PCM digital audio input
51	PCMSYNC	O	Digital 2.75V	DSP PCM frame sync
52	PCMCLK	O	Digital 2.75V	DSP PCM clock output
53	MICP	I	Analogue	Microphone Input positive
54	MICN	I	Analogue	Microphone Input negative
55	BEARP	O	Analogue	Speaker output positive
56	BEARN	O	Analogue	Speaker output negative
57	AFMS	O	Analogue	Audio output from radio device
58	SERVICE	I	2.7V	Flash programming voltage for the MS. Enable logger information if not flashing.
59	ATMS	I	Analogue	Audio input to radio device
60	AGND	-	Analogue	Analogue ground

5.2 General Electrical and Logical Characteristics

Many of the signals, as indicated in the table above, are high-speed CMOS logic inputs or outputs powered from a 2.75V±5% internal voltage regulator, and are defined as Digital 2.75V. Whenever a signal is defined as Digital 2.75V, the following electrical characteristics apply.

Parameter	*Min.*	*Max.*	*Units*
High Level Output Voltage (V_{OH}), I_o = –2mA	2.2	2.75	V

Low Level Output Voltage (V_{OL}), I_o = 2mA	0	0.6	V
High Level Input Voltage (V_{IH})	1.93	2.75	V
Low Level Input voltage (V_{IL})	0	0.5	V

Note! Unused pins can be left floating.

5.2.1 General Protection Requirements

- All 2.75 V digital inputs will continuously withstand and suffer no damage in the power-on or power-off condition when subjected to any voltage from - 0.5 V to 3.47 V (3.3 V + 5 %).
- All 2.75 V digital outputs will continuously withstand a short circuit to any other voltage within the range 0 V to 3 V.
- All analogue outputs will continuously withstand a short circuit to any voltage within the range 0 V to 3 V.
- The SIM output signals and the SIMVCC supply will continuously withstand a short circuit to any voltage within the range 0 V to 4.1V.

Note! Although the unit should be able to withstand the higher voltages the unit should not be driven at the levels as it will result in failures over time.

5.3 Grounds

Pin	*Signal*	*Description*
2, 4, 6, 8, 10, 12	DGND	Digital ground
60	AGND	Analogue ground

There are two ground connections in the radio device, AGND (analogue ground) and DGND (digital ground). Pin assignments are shown in the table above.

Note! AGND and DGND are connected at a single point inside the radio device. They must *not* be joined together in your application.

5.3.1 Analogue Ground - AGND

AGND is the return signal, or analogue audio reference, for ATMS (Audio To Mobile Station) and AFMS (Audio From Mobile Station). It is connected to the DGND inside the radio device only. The application must not connect DGND and AGND.

Parameter	*Limit*
I_{max}	≅12.5 mA

5.3.2 Digital Ground - DGND

DGND is the reference or return signal for all system interface digital signals and is also the d.c. return for SERVICE and the power supply, VCC. Connect all DGND pins together in your application in order to carry the current drawn by the radio device.

Parameter	*Per Pin*	*Total (5 Pins)*
I_{max}	< 6.0mA	< 3.0A
I_{avg}	< 100mA	< 600mA

5.4 VCC - Regulated Power Supply Input

Pins	*Signal*	*Description*
1, 3, 5, 7, 9	VCC	regulated power supply input

Power is supplied to the radio device VCC pins, from an external source.

Connect all VCC pins together in your application in order to carry the current drawn by the radio device.

The electrical characteristics for VCC are shown in the table below.

Parameter	*Mode*	*Limit*
Vcc supply voltage	Nominal	3.6 V
	Tolerance including ripple [1]	3.4 V - 4.0 V
	Over-voltage limit	5.5 V
	Maximum ripple	< 100 mV @ <200 kHz; < 20 mV @ > 200 kHz
Maximum allowable voltage drop	Burst transmission	200 mV
Current drawn, at full TX power		< 500 mA (average)
		< 2 A (peak)

[1] Measured at system connector pins.

Note! The radio device has no internal capacitance to supply the large current peaks during GSM burst transmission. We recommend you follow these general guidelines:

- Fit a low ESR electrolytic capacitor close to the radio device:

> 1,000µF;
<10mΩ ESR.

- Make sure power supply to radio device line resistance is < 200mΩ

5.5 Battery Charging Input (CHG_IN)(Reserved for future use)

This will only be available through the embedded applications in the GM47r5/GM48r5.

Note! This has not been implemented into any versions of module software and is for future use

5.6 Turning the Radio Device ON/OFF and the External Power Signal

Turning the Radio Device On

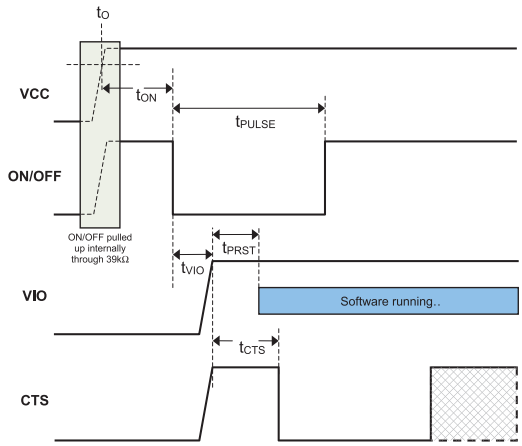

Figure 5.2 On timings and VIO performance

Symbol	*Parameters*	*Conditions*	*Min.*	*Typ*	*Max*	*Unit*
t_0	Reference time when VCC is within working limits (1)	VCC > 3.2V ON/OFF = VCC	-	-	-	-
t_{ON}	Time after t0 when the ON/OFF pulse can begin	VCC > 3.2V	0	-	-	ms
t_{VIO}	Time after start of ON/OFF pulse when VIO is active	VCC > 3.2V	-	45.0	-	ms
t_{PULSE}	Application ON/OFF pulse width	ON/OFF held low until detected by software	400	500	-	ms
t_{PRST}	*I*nternal Power-on reset signal initiates software		100	-	200	ms
t_{CTS}	Time when software controlled CTS signal indicates module READY	CTS signal configured for RS232 hardware flow control, not GPIO pin	-	0.35	3.0(2)	s

(1) The GM47r5 measures the voltage at VCC during the power-up sequence. It is important that both VCC and ON/OFF reach a minimum of 3.2V before the ON/OFF low pulse is initiated.

(2) In SERVICE mode.

Turning the Radio Device Off

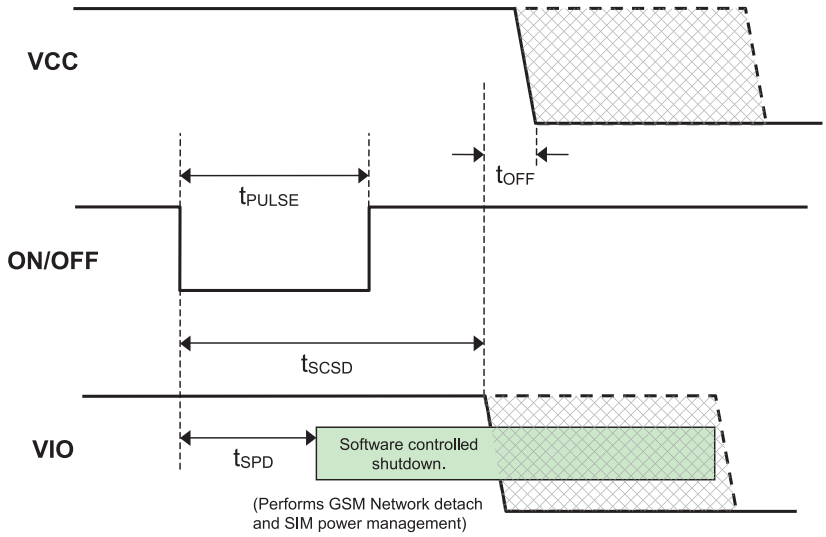

Figure 5.3 Off timings and VIO performance

Symbol	*Parameters*	*Conditions*	*Min.*	*Typ*	*Max*	*Unit*
t_{SPD}	Time for software pulse detection which initiates a software shutdown		800	-	-	ms
t_{PULSE}	Application ON/OFF pulse width		1000	-	-	ms
t_{SCSD}	Software controlled shutdown deactivates VIO (2)		-	2.5	10(3)	s
t_{OFF}	Time when VCC power supply can be disabled	VIO is DISABLED	0	-	-	ms

(2) It is a requirement from most GSM network providers that GSM products properly detach from the network during a power-down sequence. In order to achieve this it is important that the VCC supply is not removed or turned off before VIO has been deactivated by the module.

Hard Shutdown Sequence

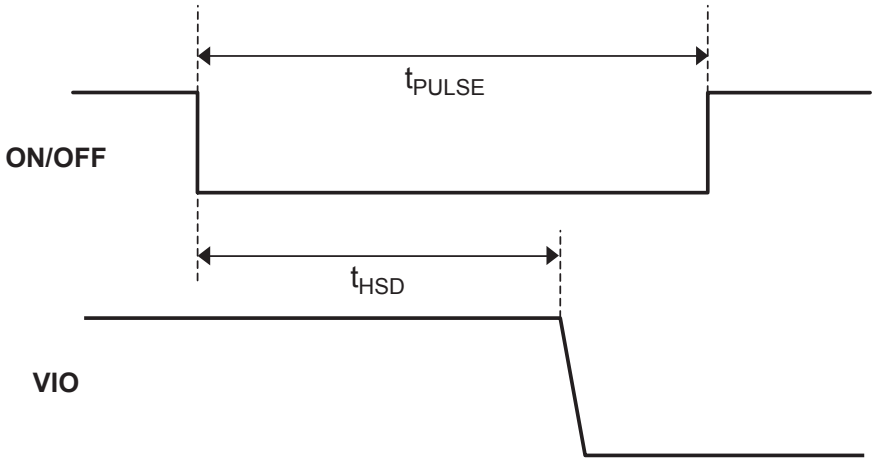

Figure 5.4 Hard Shutdown Sequence

Symbol	*Parameters*	*Conditions*	*Min.*	*Typ*	*Max*	*Unit*
t_{HSD}	Time to complete hardware shutdown		2	-	11	s
t_{PULSE}(4)	Application ON/OFF pulse width	ON/OFF low until VIO is disabled	t_{HSD}	10	-	s

(4) To implement the Hard Shutdown of the GM47r5, the ON/OFF pulse must be held low until the sequence is complete. Ensure that ON/OFF is not released before VIO has been deactivated by the module.

A hard shut down is only necessary where a normal power down has failed, this should only happen if the software has 'greyed out'. This has never been seen in the modules but is a safety mechanism build into the chipset where the power will be cut from the chips enabling the unit to be powered up normally.

5.6.1 VIO - 2.75V Supply

VIO provides an output voltage derived from an internal 2.75V regulator. Its electrical characteristics are shown below.

Parameter	*Min.*	*Typ.*	*Max.*	*Units*
Output Voltage (I_{load} = 50 mA)	2.70	2.75	2.85	V
Load current			75	mA

You can use this output for the following:

- to indicate that the radio device is powered;
- to power interface circuits, external to the radio device.

5.7 Analogue Audio

Pin	*Signal*	*Dir*	*Description*
57	AFMS	O	Audio from mobile station
59	ATMS	I	Audio to mobile station
60	AGND	-	Ground (return) for analogue audio

ATMS is the audio input, and AFMS is the audio output, of the radio device. These signals can be used in car kit mode.

There are three factory-set audio profiles:

- portable handsfree
- handset
- car kit

Portable handsfree is the factory-set default profile. The modification, configuration, manipulation and storage of audio profiles is achieved with the AT*E2EAMS (Audio Profile Modification) and AT*E2APR (Audio Profile).

5.7.1 Audio To Mobile Station - ATMS

ATMS is the analogue audio input to the radio device. Internally, the signal is sent to the CODEC (COder/DECoder), where it is converted to digital audio in PCM (Pulse Code Modulation) format. The encoded audio is sent to PCMOUT via the internal PCM bus.

ATMS provides a DC bias when it is used as the microphone input in Portable Handsfree applications. All other sources must be a.c.coupled to avoid attenuation of low frequencies, and to prevent incorrect biasing or damage to the ATMS input. Use a capacitor greater than the value shown in the table below.

The ATMS input is a passive network followed by the transmit part of the CODEC.

Parameter		*Limit*
Application driving impedance (0.3 - 3.5 kHz)		≤ 300 Ω
AC coupling capacitance		≥ 1 µF
Radio device input impedance (0.3 - 3.5 kHz)		> 50 kΩ
Low frequency cut-off (- 3 dB)		300 Hz ± 50 Hz
High frequency cut-off (– 3 dB)		> 3500 Hz ± 50 Hz
Output d.c. bias level	car kit mode	0 V

Additional Gain in car kit mode	28.5 dB

The following tables show the nominal PGA (programming gain settings). For more information see the relevant AT commands.

Maximum input voltage limit: 245 mV_{rms}

Input	*Input (mV_{rms})*	*TXAGC (dB)*	*AUX AMP gain*	*PCMOUT (dBm0)*
ATMS	245	0	13	3

Maximum input level at MICI, 61.4 mV_{rms} output at PCMOUT = 3 dBm0

Input	*Differential input (mV_{rms})*	*TXAGC (dB)*	*AUX AMP gain*	*PCMOUT (dBm0)*
MICN MICP	61.4	0	25	3

Output at AFMS for 3 dBm0 at PCMIN

Input	*dBm0*	*RXPGA*	*Volume control (dB)*	*AFMS (mV_{rms})*
PCMIN	3	0	0	436

Output at BEARN/BEARP for 3 dBm0 at PCMIN

Input	*dBm0*	*RXPGA*	*Volume control (dB)*	*BEAR (mV_{rms})*
PCMIN	3	0	0	388

5.7.2 Audio From Mobile Station - AFMS

AFMS is the analogue audio output from the radio device and may be used to drive a speaker or the ear-piece in a car kit.

PCM digital audio signals, entering the radio device through the PCMIN pin, are translated to analogue signals by the CODEC. See *PCM Digital Audio* for further information.

The table below shows the audio signal levels for AFMS.

Parameter	*Limit*
Speaker impedance	64 Ω to 1 kΩ
Output Capacitance	2.2 µF ±10 %

Levels (THD < 5 %)	Drive capability into 5 kΩ (0.3 - 3.5 kHz)	> 2.4 V_{p-p}
	Drive capability into 1.5 kΩ (0.3 - 3.5 kHz)	> 2.2 V_{p-p}
	Drive capability into 150 Ω (at 1 kHz)	> 1.3 V_{p-p}

5.7.3 Microphone Signals

Pin	*Speaker signals*	*Dir*	*Function*
53	MICP	I	Microphone positive input
54	MICN	I	Microphone negative input

MICP and MICN are balanced differential microphone input pins. These inputs are compatible with an electret microphone. The microphone contains an FET buffer with an open drain output, which is supplied with at least +2 V relative to ground by the radio device as shown below.

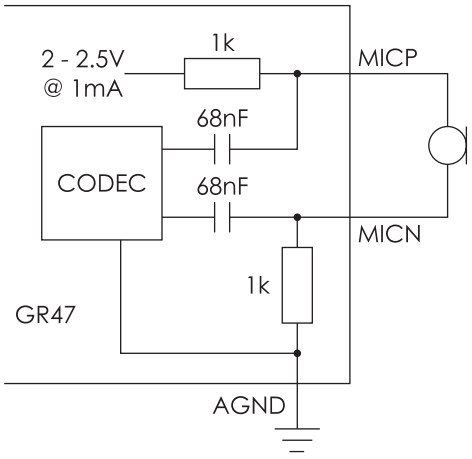

Figure 5.5 Microphone connections to the radio device

5.7.4 Speaker Signals

Pin	*Speaker signals*	*Dir*	*Function*
55	BEARP	O	Speaker positive output
56	BEARN	O	Speaker negative output

BEARP and BEARN are the speaker output pins. These are differentialmode outputs. The electrical characteristics are given in the table below.

Parameter	*Limit*
Output level (differential)	$\geq$4.0 V_{pp}
Output level (dynamic load = 32 Ω)	$\geq$2.8 V_{pp}
Gain PCMIN[5] to BEARP/BEARN (differential)	– 9 dB ± 1
Distortion at 1 kHz and maximum output level	$\leq$ 5 %
Offset, BEARP to BEARN	± 30 mV
Ear-piece mute-switch attenuation	$\geq$40 dB

[5] See PCMIN signal in.

The following table shows the ear piece impedances that can be connected to BEARP and BEARN.

Ear piece model	*Impedance*	*Tolerance*
Dynamic ear piece	[32 Ω + 800 µH] // 100 pF	± 20 %
Dynamic ear piece	[150 Ω + 800 µH] // 100 pF	± 20 %
Piezo ear piece	1 kΩ + 60 nF	± 20 %

5.8 PCM Digital Audio

Pin	*Signal*	*Dir*	*Function*
52	PCMCLK	O	PCM clock
51	PCMSYNC	O	PCM frame sync
47	PCMULD	I	PCM audio input to DSP
48	PCMDLD	O	PCM audio output from DSP
50	PCMIN	I	PCM audio input to Codec
49	PCMOUT	O	PCM audio output to Codec

Figure 5.6 shows the PCM (Pulse Code Modulation) digital audio connection for external devices. These connections can be used to process PCM digital audio signals, bypassing the radio device's internal analogue audio CODEC.

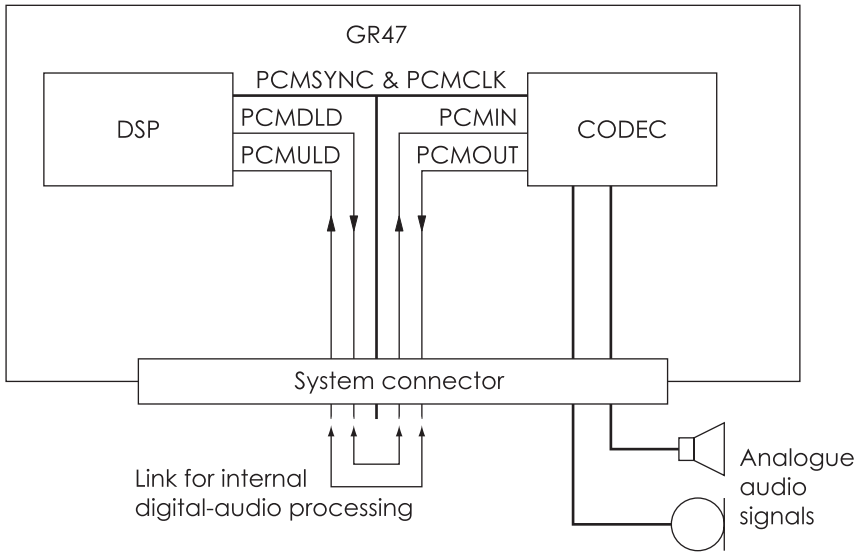

Figure 5.6 Pin connections to digital audio

Note! When no external audio processing is performed, the following pins must be connected together:

- PCMDLD to PCMIN
- PCMULD to PCMOUT

Electrical characteristics

Digital 2.75 V CMOS input/output electrical characteristics apply.

5.8.1 PCM Data Format

All of the radio device's PCM signals, including signals between its CODEC and DSP conform to the PCM data I/O format of the industry standard DSP from Texas Instruments.

PCMCLK (bit clock) and PCMSYNC (frame synchronisation) are both generated by the DSP within the radio device.

The DSP within the radio device is the master therefore all external PCM clocks and data from external devices must be synchronized to it

13-Bit PCM Mode

Bit	*Contents*
D15 to D14	Equal to D13
D13 to D1	Two's complement of the 13-bit PCM
D0	LSB, not used

The radio device implements 13-bit PCM with the 13-bit data embedded in a 16-bit word within a 24-bit frame (see Figure 5.8). Each PCM word contains 16-bits: D0 to D15. D13 to D1 is the two's complement value of the 13-bit PCM, with D13 as the sign bit. D14 and D15 are always set to be equivalent with D13. D0, the LSB, is not used as shown in Figure 5.7 below.

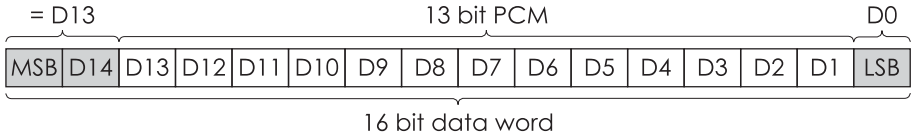

Figure 5.7 16-bit data word format

16-Bit PCM Mode

Bit	*Contents*
D15 - D0	Two's complement

The frame format is equal to the one shown in Figure 5.7, but with D15, D14 and D0 filled with significant bits. D15 to D0 is the two's complement value of the 16-bit PCM with bit 15 as the sign bit.

PCM Timing Diagrams

The PCM timing is shown in Figure 5.8below and it is seen that the CPU has 45 µs to serve an interrupt and setup data channels. Data is sent on the falling edge of the sync pulse. The data bits in PCMULD and PCMDLD are aligned so that the MSB in each word occurs on the same clock edge as shown in Figure 5.9.

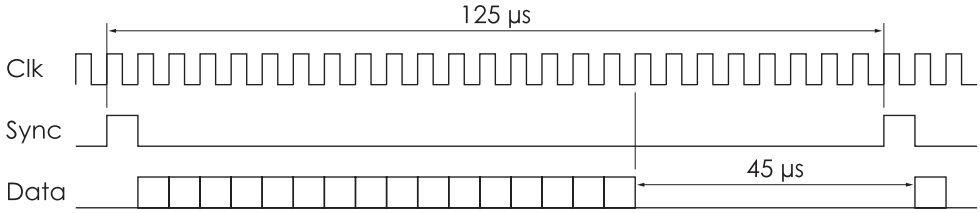

Figure 5.8 16-bit word within 24-bit frame

PCM signal timing is shown in Figure 5.9. The signals characteristics are described in the tables following Figure 5.9.

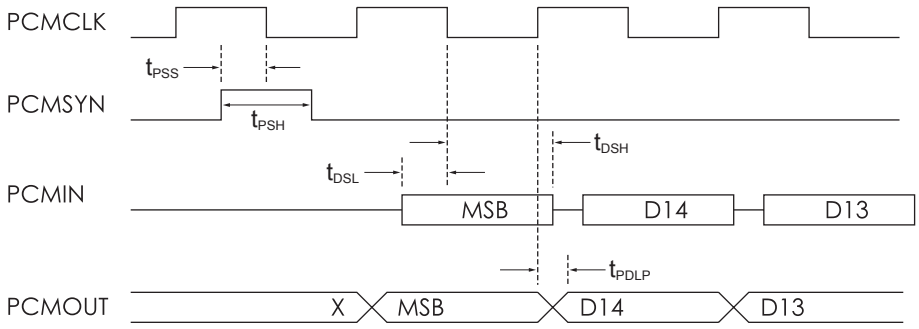

Figure 5.9 PCM Timing Diagram

Name	*Description*	*Typ.*	*Unit*
t_{PSS}	PCMSYN (setup) to PCMCLK (fall)	2.5	µs
t_{PSH}	PCMSYN pulse length	5	µs
t_{DSL}	PCMI (setup) to PCMCLK (fall)	2.5	µs
t_{DSH}	PCMI (hold) from PCMCLK (fall)	2.5	µs
t_{PDLP}	PCMO valid from PCMCLK (rise)	2.5	µs

Name	*Description*	*Typ.*	*Unit*
F_{PCMCLK}	PCM clock frequency	200	kHz

T_{PCMCLK}	PCM clock period with 50/50 mark space ratio	5	µs
F_{PCMSYN}	PCM sync frequency	8	kHz

Typical Rise/Fall times	*Rise Time*	*Fall Time*	*Unit*
PCMCLK	19	18	ns
PCMSYN	19	15	ns
PCMOUT	900	900	ns
PCMDLD	20	19	ns

5.9 Serial Data Interfaces

Pin	*Signal*	*Dir*	*Description*	*RS232 CCITT*
41	TD	I	Serial data to radio device (UART1)	103
42	RD	O	Serial data from radio device (UART1)	104
39	RTS IO9	I I/O	Request To Send (UART1) General purpose input/output 9	105
40	CTS O4	O O	Clear To Send (UART1) General purpose output 4	106
37	DTR IN1	I I	Data Terminal Ready (UART1) General purpose input 1	108.2
32	DSR O3	O O	Data Set Ready (UART) General purpose output 3	107
38	DCD O1	O O	Data Carrier Detect (UART1) General purpose output 1	109
36	RI O2	O O	Ring Indicator (UART1) General output 2	125
45	TD2	I	Transmitted Data (UART2)	
46	RD2	O	Received Data (UART2)	
43	TD3	I	Transmitted Data (UART3)	
44	RD3	O	Received Data (UART3)	

The serial channels, consisting of three UARTs, are asynchronous communication links to the application or accessory units.

- UART1 has RS-232 functionality and is used for all on- and off -line communication.

- UART2 behaves as a general-purpose serial data link. For example, it can be used for GPS, downloading software and receiving logging information.
- UART3 behaves as a general purpose serial data link. It is the only UART that can be used by the embedded application.

Note! Digital 2.75V CMOS input/output electrical characteristics apply.

The standard character format consists of 1 start bit, 8 bit data, no parity and 1 stop bit. In all, there are 10 bits per character.

5.9.1 UART1 (RS232) - RD, TD, RTS, CTS, DTR, DSR, DCD and RI

UART1 signals conform to a 9-pin RS232 (V.24) serial port.

Note! UART1 signal levels do not match standard RS232 (V.28) levels. The relationship between the levels is shown in the table below.

RS232 level	*RD, TD*	*RTS, CTS, DTR, DSR, DCD,*	*CMOS level*
< – 3 V	1	OFF	> 1.93 V
> + 3 V	0	ON	< 0.80 V

Conversion between the radio device CMOS levels and RS232 levels can be achieved using a standard interface IC, such as the Maxim Integrated Products MAX3237.

5.9.2 Serial Data Signals - RD, TD

The default baud rate is 9.6 kbits/s, however higher bit rates of up to 460 kbits/s are supported, set by an AT command. UART1 starts at a rate of 9.6 kbits/s in standard AT command mode. The radio device also supports GSM 07.10 multiplexing protocol and starts when the appropriate command is sent.

Serial Data From Radio Device (RD)

RD is an output signal that the radio device uses to send data via UART1 to the application.

Parameter	*Limit*
Application load resistance	< 100 kΩ
Application load capacitance	< 100 pF

Serial Data To Radio Device (TD)

TD is an input signal, used by the application to send data via UART1 to the radio device.

Parameter	*Limit*
Application driving impedance	< 100 Ω
Input capacitance	1nF
Input resistance	100 kΩ to 2.75 V

5.9.3 Control Signals - RTS, CTS, DTR, DSR, DCD, RI

UART1 control signals are active low and need a standard interface IC, such as the MAX3237, to generate standard RS232 levels.

UART1 converted signals, together with DGND, RD and TD form a 9pin RS232 data port.

RTS and CTS are capable of transmitting at 1/10th of the data transmission speed for data rates up to 460 kbit/s (byteoriented flow control mechanism).

Note! When hardware flow control is not used in communications between the application and the radio device, RTS and CTS must be connected to each other at the radio device.

Switching times for RTS and CTS

The table below shows the switching times.

Parameter	*Limit*
Time from Low to High level	< 2 µs
Time from High to Low level	< 2 µs

Request to Send (RTS)

Used to condition the DCE for data transmission. The default level is high by internal pull up.

The application must pull RTS low to enable data transmission from the radio device. Similarly, the radio device asserts CTS low, indicating it is ready to receive data transmission from the host.

Parameter	*Limit*
Application driving impedance	< 100 Ω

Input capacitance	< 2 nF
Input resistance (pull-up)	100 kΩ to DGND

Clear To Send (CTS)

CTS is asserted by the DCE to indicate that the host (DTE) may transmit data. When CTS is high, the host (DTE) is not permitted to transmit data.

The table below shows the load characteristics for this signal.

Parameter	*Limit*
Application load capacitance	< 500 pF
Application load resistance	≥ 1 MΩ

Data Terminal Ready (DTR)

DTR indicates that the DTE is ready to receive data. It also acts as a hardware ‘hang-up’, terminating calls when switched high. The signal is active low. You can define the exact behaviour of DTR with an AT command.

Data Set Ready (DSR)

DSR indicates that the DCE is ready to receive data. The signal is active low.

Data Carrier Detect (DCD)

DCD indicates that the DCE is receiving a valid carrier (data signal) when low.

Ring Indicator (RI)

RI indicates that a ringing signal is being received by the DCE when low. You can define the exact behaviour of RI with an AT command.

5.9.4 UART2 - TD2, RD2

UART 2 consists of a full duplex serial communication port with transmission and reception lines.

This communication port works in a mode called Operation and Maintenance.

Operation and Maintenance mode works in combination with the SERVICE signal. Two events are possible if the SERVICE signal is active when the radio device is turned on. These are:

- the radio device is reprogrammed if UART2 is connected to a computer running Sony Ericsson update software;
- the radio device enters logging mode and sends data to UART2 if no reprogramming information is received.

Timing and electrical signals characteristics are the same as for UART1, TD and RD, except for maximum baud rate which could increase to 921 kbps.

Transmitted Data 2 (TD2)

TD2 is used by the application to send data to the radio device via UART2. It has the same electrical characteristics as TD.

Received Data 2 (RD2)

RD2 is used to send data to the application via UART2. It has the same electrical characteristics as RD.

5.9.5 UART3 - TD3, RD3

UART3 is a full duplex serial communication port with transmission and reception lines. It has the same timing and electrical signal characteristics as UART1, TD and RD.

Transmitted Data 3 (TD3)

TD3 is used by your application to send data to the radio device via UART3.

Received Data 3 (RD3)

RD3 is used to send data to your application via UART3.

5.10 SIM Card Related Signals

Pin	*Signal*	*Dir*	*Description*
15	SIMVCC	-	SIM card power supply
16	SIMPRESENCE	I	SIM card presence
17	SIMRST	O	SIM card reset
19	SIMCLK	O	SIM card clock
18	SIMDATA	I/O	SIM card data

These connections allow you to communicate with the SIM card holder in your application.

Note! The distance between the SIM card holder and the radio device can be up to 25cm.

This SIM interface allows the use of 3 V and 5 V SIM cards. By default it works on 3 V levels but will automatically switch to 5 V, if a 5 V SIM card is fitted.
SIM voltage levels, as shown in the following table, are dependent on the type of SIM card detected by the radio device.

Signal	*Parameter*	*Mode*	*Min.*	*Typ.*	*Max.*	*Unit*
SIMVCC	SIM supply voltage	3 V	2.7	3.0	3.3	V
		5 V	4.5	5.0	5.5	V
SIMDAT	High Level Input voltage (V_{IH})	3 V	2.1		3.0	V
		5 V	3.5		5.0	V
SIMDAT	Low Level Input voltage (V_{IL})	3 V	0		0.9	V
		5 V	0		1.5	V
SIMDAT	High Level Output voltage (V_{OH})	3 V	2.7		3.0	V
		5 V	4.7		5.0	V
SIMDAT	Low Level Output voltage (V_{OL})	3 V	0		0.2	V
		5 V	0		0.2	V
SIMCLK SIMRST	High Level Output voltage (V_{OH})	3 V	2.4		3.0	V
		5 V	4.4		5.0	V
SIMCLK SIMRST	Low Level Output voltage (V_{OL})	3 V	0		0.35	V
		5 V	0		0.3	V

5.10.1 SIM Detection - SIMPRESENCE

SIMPRESENCE is used to determine whether a SIM card has been inserted into or removed from the SIM card holder. You should normally wire it to the “card inserted switch” of the SIM card holder, but different implementations are possible.

When left open, an internal pull-up resistor maintains the signal high and means “SIM card missing” to the radio device. When pulled low the radio device assumes a SIM card is inserted.

SIMPRESENCE is a Digital 2.75V CMOS input with the following electrical characteristics.

Parameter	*Min.*	*Typ.*	*Max.*	*Units*
Pull-up resistance (at 2.75 V)	100			kΩ
Low Level Input voltage (SIM inserted)			0.80	V
High Level Input voltage (SIM missing)	> 1.93		2.75	V

Note! To meet regulatory approvals SIMPRESENCE must be implemented.

5.11 Service/Programming

Pin	*Signal*	*Dir*	*Description*
58	SERVICE	I	Flash programming voltage

When the SERVICE input signal is active the radio device will:

- be reprogrammed if data is received through UART2 from a computer running Sony Ericsson reprogramming software;
- or it will output logging data on UART2.

The electrical characteristics are given below. The signal reference is DGND.

Mode	*SERVICE Voltage (V)*			*Drive Capacity*
	Min.	*Typ.*	*Max.*	
Normal Operation			0.8	-
Service/enable programming	1.9	2.75V	3.6	> 1 mA
Absolute maximum voltage			13.5	

5.12 Buzzer

Pin	*Signal*	*Dir*	*Description*
31	BUZZER	O	Buzzer output from radio device

Connecting the BUZZER signal to an inverting transistor-buffer followed by a piezoelectric transducer enables the radio device to play pre-programmed melodies or sounds.

5.13 LED

Pin	*Signal*	*Dir*	*Description*
33	LED	O	LED Output from radio device

The LED states shown below, are hard coded

LED indication	*Operational status*
No indication	No power or in the OFF state
Green, steady	Power on, not connected to a network
Green, blinking	Power on, connected to a network

The following circuit is recommended for connecting an LED.

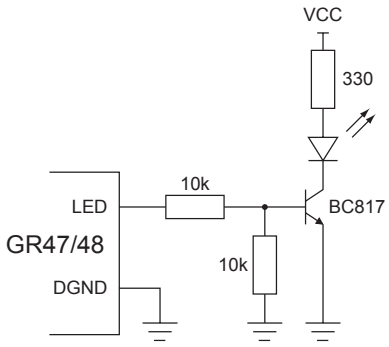

Figure 5.10 Electrical connections for the LED

5.14 General Purpose Digital I/O Ports

Pin	*I/O port signal*	*Default signal*	*Description*
21	IO1	IO1	Programmable Input/Output 1
22	IO2	IO2	Programmable Input/Output 2 ADC5
23	IO3	IO3	Programmable Input/Output 3
24	IO4	IO4	Programmable Input/Output 4
13	IO5	IO5	Programmable Input/Output 5 ADC4
33	IO6	LED	Programmable Input/Output 6/LED
43	IO7	TD3	Programmable Input/Output 7/TD3
44	IO8	RD3	Programmable Input/Output 8/RD3
39	IO9	RTS	Programmable Input/Output 9/RTS
37	IN1	DTR	Programmable Input 1 Data Terminal Ready
32	OUT3	DSR	Programmable Output 3/DSR
36	OUT2	RI	Programmable Output 2/RI Ring Indicator

38	OUT1	DCD	Programmable Output 1/DCD Data Carrier Detect
40	OUT4	CTS	Programmable Input/Output 4/CTS

Signals which have an entry in the Default Signal column in the above table are multiplexed.

The operational modes of multiplexed signals are controlled by AT commands and also by intrinsic functions available to an embedded application.

The following table gives you the input impedance. These values only apply when the ports are configured as input signals.

Parameter	*Min.*	*Typ.*	*Max.*	*Units*
Input impedance (pull-up)	50	100	120	kΩ

Note! I/O6 (LED) doesn't have an internal pull up. If this pin is configured as an input, it should not be left floating.
I/O7 (TD3) has a pull down instead of a pull up.

5.15 Extended I/O capabilities

To increase flexibility and variety of radio device peripherals, the RS232 hardware flow control shares its physical interface with the extended general purpose I/O capability. This sharing means that it is not feasible to operate all these features concurrently, however, with care, dynamic switching from one feature to another is possible.

5.15.1 LED/IO6 Capabilities

The LED function pin can be used as a general purpose digital I/O when the flashing LED function is not required. However, this pin does not have an on-board pull-up resistor. It is required that an external pull-up or pull-down resistor be provided by the host circuitry when either not used or when used as a digital input.

5.15.2 I#/O#

If pins labelled I# and O# are not being used for an alternative function they may be used for general purpose inputs or outputs respectively. The inputs have an on-board 100k pull-up resistor and the outputs are driven rail-to-rail at 2.75V levels.

5.15.3 UART3/IO#

The UART3 pins have been given alternative functions as general purpose I/O, both pins may be used for either input or output. However, the TX pin has a 100kΩ pull-down resistor to ground and the RX pin has a 100kΩ pull-up resistor to 2.75V. This must be taken into consideration when designing the host circuit.

5.15.4 IO#/ADC#

To increase analog input capabilities, the radio device optimises the I/O by multiplexing or sharing different features on single pins. There are two digital I/O pins which now have an additional ADC input. When configured as digital I/O, the software will not read the voltages at the two new ADC inputs. When configured as ADC inputs the software will configure the digital I/O pins as input or high impedance tri-state. In this state any applied voltage between 0V and 2.75V can be read as an 8 bit value.

Because the additional ADC inputs (ADC4 and ADC5) are common with digital I/O, the input circuit of the ADC is not the same as for the original circuits ADC1-3. It is important to understand the input structure of the pin so that the correct analog voltage is read by the application.

5.16 General Purpose Analogue I/O Ports

Pin	*Signal*	*Dir*	*Description*
20	DAC	O	Digital to analogue conversion output
26	ADC1	I	Analogue to digital conversion input 1
27	ADC2	I	Analogue to digital conversion input 2
28	ADC3	I	Analogue to digital conversion input 3
13	ADC4 (I/O5)	I (I/O)	Analogue to digital conversion input 4
22	ADC5 (I/O2)	I (I/O)	Analogue to digital conversion input 5

The radio device is able to convert digital to analogue signals and vice versa.

5.16.1 Digital to Analogue Converter - DAC

The DAC is an 8-bit converter. Conversion takes place when an AT command is sent to the radio device. The radio device sends the resulting analogue value to the DAC pin.

Tolerance on this internal voltage is ±5%.

DAC output electrical characteristics are given in the following table.

Parameter	*Limit*	*Units*
Resolution	8	Bits
Output voltage for code = 0	(2.75[6] x 0.05) ± 0.05	V
Output voltage for code = 255	(2.75[6] x 0.95) ± 0.05	V
Nominal step size	(2.75[6] x 0.9)/256	mV
Absolute error[7]	≤ ± 0.5	mV
Output wide-band noise and clock feedthrough 0 - 1.1 MHz	≤ 0.5	mV_{rms}
Power-supply rejection ratio 50 Hz - 10 kHz	≥ 40	dB
Conversion rate ± 0.5 LSB	≤ 2 (Load A)[8]	ms
	≤ 50 (Load B)[8]	ms
Output buffer impedance when disabled	≥ 50	kΩ
Output current source or sink	≥ 1	mA
Current consumption (active)	≤ 1.0	mA

[6]Tolerance on this internal voltage is ± 5 %

[7]Referred to the ideal conversion characteristic.

[8]See Figure 5.11

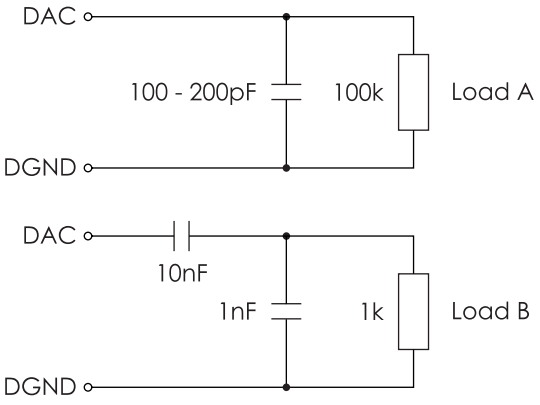

Figure 5.11 DAC loads

5.16.2 Analogue to Digital Converters 1, 2 and 3 - ADCx

The ADC is an 8-bit converter. An analogue value applied to any of the ADC pins is converted and stored in a register inside

the radio device. When the appropriate AT command is received by the radio device, the digital value stored in the register is read.

ADC electrical characteristics are shown in the table below.

Parameter	*Min.*	*Max.*	*Units*
Resolution	8	8	Bits
Input voltage for 0000 0000 word	0	0.01 x 2.75[9]	V
Input voltage for 1111 1111 word	0.99 x 2.75[9]	2.75[9]	V
Differential Non-Linearity (DNL)		±0.75	LSB
Overall Non-Linearity (INL)		±0.60	LSB
Absolute accuracy		±1.5	LSB
Input impedance	1		MΩ
Average supply current (continuous conversion)		1	mA
External source impedance		50	kΩ

[9] Tolerance on this internal voltage is ±5%

5.16.3 Analogue to Digital Converters 4 and 5 - IOx/ADCx

To increase analog input capabilities, the GM47r5 optimises the I/O by multiplexing or sharing different features on single pins. There are two ADC inputs which share system connector pins with digital I/O signals. When configured as digital I/O, the software will not read the voltages at the two new ADC inputs. When configured as ADC inputs the software will configure the digital I/O pins as input or high impedance tri-state. In this state any applied voltage between 0V and 2.75V can be read as an 8 bit value.

Because the ADC inputs, ADC4 and ADC5, are common with digital I/O, the input circuit of these ADCs is not the same as for the circuits ADC1, ADC2 and ADC3. It is important to understand the input structure of the pin so that the correct analog voltage is read by the application (at position 'A' in Figure 5.12 below). The input structure is provided in Figure 5.12. It consists of a 100kΩ pull-up to 2.75V followed by a series 10kΩ and 1nF capacitor to ground which make a low pass filter with a 3dB roll-off at about 16kHz. The input impedance of the analog IC is 1MΩ minimum. At position 'A' in Figure 5.12 below, the input characteristics are the same as for the table above.

Note! If the voltage of the signal to be measured may be altered by the internal circuitry of this shared signal, then the application should use ADC1, ADC2 or ADC3 instead.

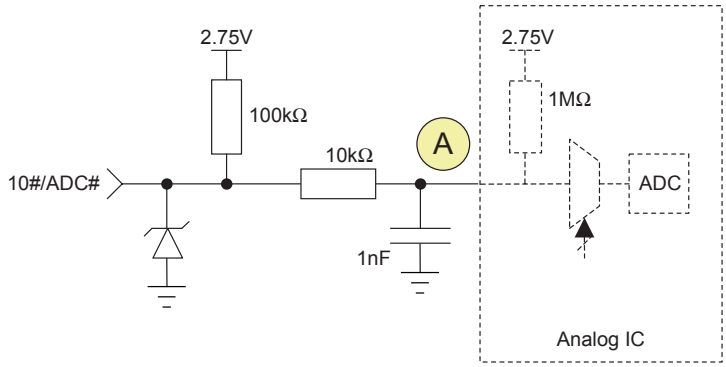

Figure 5.12 Input circuit for combined digital I/O and ADC pins

5.17 External I²C Serial Control Bus

Pin	*Signal*	*Dir*	*Description*
29	SDA	I/O	I²C serial data
30	SCL	O	I²C serial clock

The I²C bus is controlled by embedded application script commands it is not available in the GM47r5.

The external I²C bus consists of two signals, SDA and SCL. This bus is isolated from the radio device's internal I²C bus to ensure proper operation of the radio device, in the event of the external I²C bus being damaged.

The electrical characteristics are shown below.

	Parameter	*Min.*	*Typ.*	*Max.*	*Units*
Transmit operation	Frequency I²C CLK	81.25		400	kHz
	High or low I²C CLK	1.2			µs
	Delay time after falling edge of I²C CLK	308	308-1230		ns
	Hold time after falling edge of I²C CLK	0			ns
Receive operation	Frequency I²C CLK			400	kHz
	High or low I²C CLK	1.2			µs
	Delay time after falling edge of I²C CLK	100			ns

	Hold time after falling edge of I^2C CLK	0		ns

5.18 TX_ON - Burst Transmission

Pin	*Signal*	*Dir*	*Description*
35	TX_ON	O	GSM radio device to transmit

Burst transmission is the time when a GSM transceiver unit is transmitting RF signals. TX_ON indicates the radio device is going into transmission mode.

5.19 Real Time Clock

Pin	*Signal*	*Dir*	*Description*
25	VRTC	-	Voltage for the Real Time Clock

The Real Time Clock (RTC) provides the main microprocessor with a time-of-day calendar and alarm, and a one-hundred-year calendar. Its accuracy is shown in the table below

Parameter	*Min.*	*Typ.*	*Max.*	*Units*
RTC accuracy	25ûC	8 (21)	20 (52)	ppm (s/month)
RTC accuracy	extreme temperatures	89 (231)	101 (262)	ppm (s/month)

The Real Time Clock operates in two modes when connected to a separate power supply:

- RTC normal mode: the radio device is in ON or OFF mode and it is supplied with power (VCC is applied).
- RTC back-up mode: VCC is disconnected and the RTC is maintained by a separate backup power supply connected to the VRTC input (see Figure 5.13 below).

Backup power is provided by a capacitor, golden-capacitor or battery in your application and must be connected to the VRTC pin. During RTC normal operation, the back up source will be charged.

In back-up mode, the back-up source must provide enough power for RTC operation. Refer to the table for the amount of current required.

The following table shows voltage characteristics for both modes.

Parameter	*Min.*	*Typ.*	*Max.*	*Units*
Supply Voltage RTC (normal mode - charging the capacitor)	1.6	1.8	2.0	V
Supply Voltage RTC (back-up mode - Capacitor provides the current)	1.0	1.8	2.0	V
Current drawn		5.0	10.0	µA

If the voltage drops below 1.0 V in back-up mode, the RTC will stop working. The following diagram shows the RTC connections.

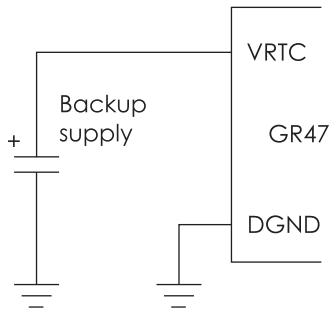

Figure 5.13 RTC connections

6 Antenna Connector

The radio device's antenna connector allows transmission of the radio frequency (RF) signals from the radio device to an external customer-supplied antenna. The connector is a micro-miniature coaxial MMCX surface mounted component. A number of suitable MMCX type, mating plugs are available from the following manufacturers;

- Amphenol;
- Suhner;
- IMS Connector Systems.

The nominal impedance of the antenna interface is 50Ω.

7 Hints for Integrating the Radio Device

This chapter gives you advice and helpful hints on how to integrate the radio device into your application from a hardware perspective.

Please read and consider the information under the following headings before starting your integration work:

- Safety advice and precautions.
- Installation of the radio device.
- Antenna.

7.1 Safety Advice and Precautions

7.1.1 General

- Always ensure that use of the radio device is permitted. The radio device may present a hazard if used in proximity to personal medical electronic devices. As a rule, the radio device must not be used in hospitals, airports or planes.
- You are responsible for observing your country's safety standards, and where applicable the relevant wiring rules.
- Never use the radio device at a gas station, refuelling point, blasting area or in any other environment where explosives may be present.
- Operating the radio device close to other electronic devices, such as antennas, television sets, and radios may cause electromagnetic interference.
- Never try to dismantle the radio device yourself. There are no components inside the radio device that can be serviced by the user. If you attempt to dismantle the radio device, you may invalidate the warranty.
- To protect the power supply cables and meet the fire safety requirements, it is recommended that the electrical circuits are supplied with a power regulator. The power regulator should be placed as close to the terminals of the power supply as possible.
- Do not connect any incompatible component or product to the radio device.

Note! Sony Ericsson does not warrant against defects, non-conformities or deviations caused thereby.

- The connection/disconnection method for the development board is by means of the DC power jack. For this reason, the mains supply should be situated close to the development board and be easily accessible.

7.1.2 SIM Card

- Before handling the SIM card in your application, ensure that you are not charged with static electricity. Use proper precautions to avoid electrostatic discharges. The radio device must be switched off before the SIM card is installed in your application.
- When the SIM card hatch is opened, the SIM card connectors lie exposed under the SIM card holder. CAUTION: Do not touch these connectors! If you do, you may release an electrical discharge that could damage the radio device or the SIM card.
- When designing your application, the SIM card's accessibility should be taken into account. We always recommend that you have the SIM card protected by a PIN code. This will ensure that the SIM card cannot be used by an unauthorized person.

7.1.3 Antenna

- If the antenna is to be mounted outside, consider the risk of lightning. Follow the instructions provided by the antenna manufacturer.
- Never connect more than one radio device to a single antenna. The radio device can be damaged by radio frequency energy from the transmitter of another radio device.
- Like any mobile station, the antenna of the radio device emits radio frequency energy. To avoid EMI (electromagnetic interference), you must determine whether the application itself, or equipment in the application's proximity, needs further protection against radio emission and the disturbances it might cause. Protection is secured either by shielding the surrounding electronics or by moving the antenna away from the electronics and the external signals cable.
- The radio device and antenna may be damaged if either come into contact with ground potentials other than the one in your application. Beware, ground potential are not always what they appear to be.

- In the final application, the antenna must be positioned more than 20 cm away from human bodies. When this rule cannot be applied, the application designer is responsible for providing the SAR measurement test report and declaration.
- Even if SAR measurements are not required, it is considered good practice to insert a warning in any manual produced, indicating it is a radio product and that care should be taken.

7.2 Installation of the Radio Device

7.2.1 Where to Install the Radio Device

There are several conditions which need to be taken into consideration when designing your application as they might affect the radio device and its function. They are:

Environmental Conditions

The radio device must be installed so that the environmental conditions stated in the Technical Data chapter, such as temperature, humidity and vibration are satisfied. Additionally, the electrical specifications in the Technical Data section must not be exceeded.

Signal Strength

The radio device has to be placed in a way that ensures sufficient signal strength. To improve signal strength, the antenna can be moved to another position. Signal strength may depend on how close the radio device is to a radio base station. You must ensure that the location at which you intend to use the radio device, is within the network coverage area.

Degradation in signal strength can be the result of a disturbance from another source, for example an electronic device in the immediate vicinity. More information about possible communication disturbances can be found in section 7.3.5 page 58.

When an application is completed, you can verify signal strength by issuing the AT command AT+CSQ. See the AT Commands Manual for further details.

Note! Before installing the radio device, use an ordinary mobile telephone to check a possible location for it. In determining the location for the radio device and antenna, you should consider signal strength as well as cable length

Connection of Components to Radio Device

The integrator is responsible for the final integrated system. Incorrectly designed or installed, external components may cause radiation limits to be exceeded. For instance, improperly made connections or improperly installed antennas can disturb the network and lead to malfunctions in the radio device or equipment.

Network and Subscription

- Before your application is used, you must ensure that your chosen network provides the necessary telecommunication services. Contact your service provider to obtain the necessary information.
- If you intend to use SMS in the application, ensure this is included in your (voice) subscription.
- Consider the choice of the supplementary services described in section 2.3.2 Short Message Service, page 10.

7.2.2 How to Install the Radio Device

Power Supply

- Use a high-quality power supply cable with low resistance. This ensures that the voltages at the connector pins are within the allowed range, even during the maximum peak current. An electrolytic capacitor should be placed close to the power supply pins of the radio device to supply the peak currents during burst transmission. See 5.4 VCC - Regulated Power Supply Input.
- See section 5.2.1 General Protection Requirements, page 24.

Grounds

A ground connection is provided at the mounting hole next to the RF connector on the radio device (see figure 5.1, page 20). Connect this ground point to the DGND pins of the radio device by the shortest, low-impedance path possible. The purpose of this connection is to allow any ESD picked up by the antenna to bypass the radio device's internal ground path.

Note! It is recommended that you use a cable with a maximum resistance of 5 mΩ for the ground connection.

Note! AGND and DGND are connected at a single point inside the radio device. They must *not* be joined together in your application.

Audio

Use a coupling capacitor in ATMS line if the application does not use the radio device's bias voltage. See also Figure 5.5 Microphone connections to the radio device, page 32.

Software Upgrade

To upgrade the software, the system connector must be accessible in your application. The pins SERVICE, TD2, RD2 and the power signals are used for this purpose. Please contact customer support for more details.

7.3 Antenna

7.3.1 General

The antenna is the component in your system that maintains the radio link between the network and the radio device. Since the antenna transmits and receives electromagnetic energy, its efficient function will depend on.

- the type of antenna (for example, circular or directional).
- the placement of the antenna.
- communication disturbances in the vicinity in which the antenna operates.

In the sections below, issues concerning antenna type, antenna placement, antenna cable, and possible communication disturbances are addressed.

In any event, you should contact your local antenna manufacturer for additional information concerning antenna type, cables, connectors, antenna placement, and the surrounding area. You should also determine whether the antenna needs to be grounded or not. Your local antenna manufacturer might be able to design a special antenna suitable for your the application.

7.3.2 Antenna Type

Make sure that you choose the right type of antenna for the radio device. Consider the following requirements:

- the antenna must be designed for the dual frequency bands in use:

E-GSM900/GSM1800 for the GM47r5 and
GSM 850/GSM1900 for the GM48r5.

- the impedance of the antenna and antenna cable must be 50Ω.
- the antenna output-power handling must be a minimum of 2W.
- the VSWR value should be less than 3:1 to avoid damage to the radio device.

7.3.3 Antenna Placement

The antenna should be placed away from electronic devices or other antennas. The recommended minimum distance between adjacent antennas, operating in a similar radio frequency band, is at least 50cm.

If signal strength is weak, it is useful to face a directional antenna at the closest radio base station. This can increase the strength of the signal received by the radio device.

The radio device's peak output power can reach 2W. RF field strength varies with antenna type and distance. At 10cm from the antenna the field strength may be up to 70V/m and at 1m it will have reduced to 7V/m.

In general, CE-marked products for residential and commercial areas, and light industry can withstand a minimum of 3V/m.

7.3.4 The Antenna Cable

Use 50Ω impedance low-loss cable and high-quality 50Ω impedance connectors (frequency range up to 2GHz) to avoid RF losses. Ensure that the antenna cable is as short as possible.

The Voltage Standing-Wave Ratio (VSWR) may depend on the effectiveness of the antenna, cable and connectors. In addition, if you use an adapter between the antenna cable and the antenna connector, it is crucial that the antenna cable is a high-quality, low-loss cable.

Minimize the use of extension cables, connectors and adapters. Each additional cable, connector or adapter causes a loss of signal power.

7.3.5 Possible Communication Disturbances

Possible communication disturbances include the following:

- **Noise** can be caused by electronic devices and radio transmitters.

- **Path-loss** occurs as the strength of the received signal steadily decreases in proportion to the distance from the transmitter.
- **Shadowing** is a form of environmental attenuation of radio signals caused by hills, buildings, trees or even vehicles. This can be a particular problem inside buildings, especially if the walls are thick and reinforced.
- **Multi-path fading** is a sudden decrease or increase in the signal strength. This is the result of interference caused when direct and reflected signals reach the antenna simultaneously. Surfaces such as buildings, streets, vehicles, etc., can reflect signals.
- **Hand-over** occurs as you move from one cell to another in the GSM network. Your mobile application call is transferred from one cell to the next. Hand-over can briefly interfere with communication and may cause a delay, or at worst, a disruption.

8 TCP/IP Stack

An on board IP/TCP/UDP stack has been integrated into the software negating the need for the customer to implement one in their own code base.

The TCP/IP stack is accessible via AT commands.

8.1 Implementation

The following types of commands allow various functions:

- Open/closing IP connection - Negotiates/closes a dynamic IP address with the web server.
- Send/Receive TCP packets - Performs all TCP operations to send and receive packets.
- Send/Receive UDP packets - Performs all UDP operations to send and receive packets.
- Resolve URL to an IP address - Similar to nslookup command in DOS
- Server/listen mode - This allows the unit to negotiate an IP address for itself and then listen for incoming traffic.

The implementation effectively provides a transparent communication link from the application to an internet server over GPRS.

9 Technical Data

Mechanical Specifications

Maximum length	50 mm
Maximum width	33 mm
Maximum thickness	6.82 mm (excluding connector pins and top of antenna connector)
Weight	18.5 g

Power supply voltage, normal operation

Voltage	3.6 V nominal (3.4 V - 4.0 V)
Ripple	< 100 mV @ <200 kHz; < 20 mV @ > 200 kHz
Voltage must always stay within a normal operating range, ripple included	
Power consumption	Voice/CSD: < 250 mA (< 2 A peak)
	Data (GPRS 4+1); < 350 mA (< 2 A peak)
	Idle mode: < 5 mA
	Switched off: < 100 µA

Radio specifications

Frequency range	GM47r5: E-GSM 900 MHz and GSM 1800 MHz (dual band) GM48r5: GSM 850 MHz and GSM 1900 MHz (dual band)
Maximum RF output power	GM47r5: 900 MHz, Class 4, 2 W; 1800 MHz Class 1, 1 W GM48r5: 850 MHz, Class 4, 2W; 1900 MHz Class 1, 1 W
Antenna impedance	50 Ω

SIM card

3 V or 5 V	Support of external SIM card

Environmental specifications

Operating temperature range (full specification)	-10 °C to +55 °C
Operating temperature range (working)	-30 °C to +75 °C
Storage temperature range	-40 °C to +85 °C
Maximum relative humidity	95 % at +40 °C
Stationary vibration, sinusoidal	Displacement: 7.5 mm Acceleration amplitude: 20 m/s² and 40 m/s² Frequency range: 2-8 Hz, 8-200 Hz, 200-500 Hz
Stationary vibration, random	Acceleration spectral density (m²/s²): 0.96, 2.88, 0.96 Frequency range: 5-10 Hz, 10-200 Hz, 200-500 Hz, 60 min/axis
Non-stationary vibration, including shock	Shock response spectrum I, peak acceleration: 3 shocks in each axis and direction; 300 m/s², 11 ms Shock response spectrum II, peak acceleration: 3 shocks in each axis and direction; 1000 m/s², 6 ms
Bump	Acceleration: 250 m/s²
Free fall transportation	1.2 m
Rolling pitching transportation	Angle: ±35 degrees; period: 8 s
Static load	10 kPa
Low air pressure/high air pressure	70 kPa/106 kPa

Data Storage

SMS storage capacity	40 in ME In addition, the unit can handle as many SMS as the SIM can store
Phone book capacity	100

10 Declaration of Conformity

Declaration of Conformity

We, Sony Ericsson Mobile Communications AB of
Nya Vattentornet
S- 221 88 Lund, Sweden

declare under our sole responsibility that our product

Sony Ericsson type 6100511- BV

and in combination with our accessories, to which this declaration relates is in conformity with the appropriate standards 3GPP TS 51.010-1, EN 301489-7 and EN 60950, following the provisions of, Radio Equipment and Telecommunication Terminal Equipment directive 99/5/EC with requirements covering EMC directive 89/336/EEC, and Low Voltage directive 73/23/EEC.

CE 0682

Basingstoke, May 2003
Place & date of issue

Anders Franzén
Corporate Vice President M2M Com

We fulfil the requirements of the R& TTE Directive (99/5/EC).

11 Introduction to the Universal Developer's Kit

The developer's kit is designed to get you started quickly. It contains all the hardware you will need to begin the development of an application. The only items you need to provide are; a radio device, a computer, a SIM card with a network subscription, and a knowledge of programming with AT commands.

Note! Before connecting up and using the developer's kit, we strongly recommend you read "Integrating the Radio Device", page 16 and all of this section. There are many switches, jumpers and connector options in the developer's kit. Knowledge of the functionality of the radio device is therefore essential before you start altering the hardware settings.

The main hardware of the UDK is an open board onto which you plug the radio device. Connectors, switches, jumpers and SIM card holder are provided to allow you to configure and access all the functions of the radio device.

11.1 Contents of the Kit

Please take the time to check the contents of your kit against the list shown below. If any of the items are missing contact your supplier immediately.

Description	*Manufacturer, Part #*	*Qty*
Power Supply, 12VDC	Astrodyne, SPU45-105 or Current Solutions, TR45A1211A02	1
Power Cord, US Plug	Allied, 626-3520	1
Power Cord, Euro Plug	Allied, 626-5206	1
Power Cord, UK Plug	Allied, 626-5200	1
Serial Cable, DB9MF	Assman, AK131-2	1
Hands-Free, 2.5mm Plug	Sony Ericsson, HBH0043-015430	1
Antenna, 900/1800 MHz	Panorama Antennas Ltd., TDE-3SP	1
Antenna, 800/1900 MHz	Panorama Antennas Ltd., TAP-3SP	1

Cable, 40-pin to 30-pin ribbon interface (DM-XX)	Sony Ericsson,2/1078 TVK 117 2403	1
Cable, 40-pin to 40-pin ribbon interface (CM-xx, GM-xx)	Sony Ericsson,3/1078 TVK 117 2403	1
Cable, MMCX rt. angle to MMCX straight	Sony Ericsson,1/1078 TVK 117 2403	1
UDK Developer's Board	ROA 117 2449	1
Nut, 2-56 Hex	Digi-Key, HD723-ND	2
Nut, 4-40 Hex	Digi-Key, HD724-ND	5
Rubber Feet	Allied, SJ-5303	6
Screw, 2-56, 1/2" Length	Digi-Key, H701-ND	2
Screws, 4-40, 5/16" Length	Digi-Key, H704-ND	18
Stand-offs, 4-40, .250" O.D., 3/4" Length	Digi-Key, 3481K-ND	2
Stand-offs, 4-40, .250" O.D., 5/8" Length	Digi-Key, 1839K-ND	4
Stand-offs, 2-56, .156" O.D., 1/4" Length	Digi-Key, 1801BK-ND	2
Washer, 2-56 Lock Inside Tooth	Digi-Key, H728-ND	2
Washer, 4-40 Lock Inside Tooth	Digi-Key, H729-ND	12
Aluminum Heat-Sink	Sony Ericsson, SXA 1341627	1
Thermal Pad	Comrades, 69-11-23587-T725	1
Documentation CD	Sony Ericsson	1

Table 1: Universal Developer's Kit Content List

11.2 Assembling the Developer's Board

The developer's board has been designed to work with several families of modules. Therefore you will need to assemble the mounting hardware based on the particular version of the module you are using. There are four different assemblies: the GM-41, the DM-xx family, the CM-4x family which requires a heat sink for 3W usage, and the smaller Gx-47/48.

11.3 Mounting a GX-47/48

This assembly will require (included in kit):

Description	*Manufacturer, Part #*	*Qty*
2-56, .156" O.D., 1/4" Length Standoffs	Digi-Key 1801BK-ND	2
2-56 x 1/2" Phillips Panhead Stainless Steel Machine Screw	Digi-Key H701-ND	2
2-56 Lock Washer, Inside Tooth, Stainless Steel (Use on bottom only)	Digi-Key H728-ND	2
2-56 Hex Nut	Digi-Key HD723-ND	1

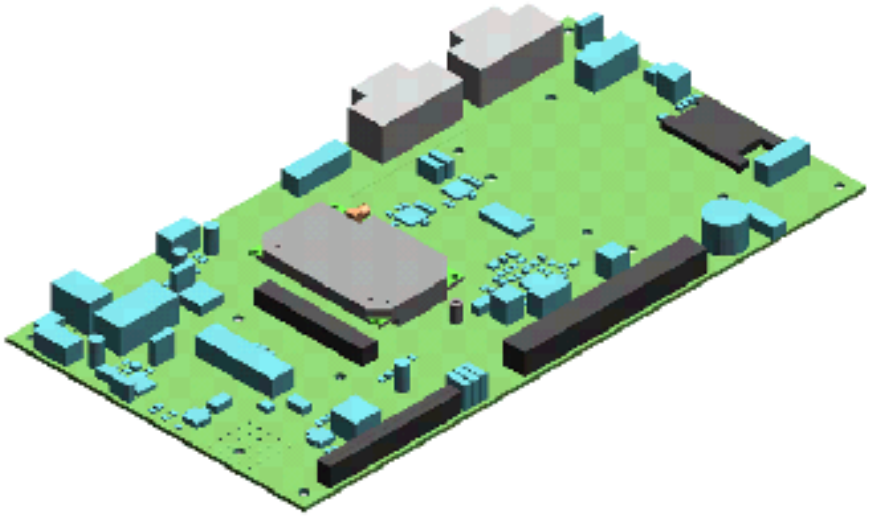

Figure 13.1 Exploded View of Developer's Board with GX-47/48

11.4 Assembly instructions:

- Use 1/2" screw with lock washer through the bottom of board to attach each 1/4" long standoff.
- Plug the module into the 60-pin connector X602.
- Attach module to standoff using a single 2-56 nut.
- Attach RF cable from module to J402. Make RF connections at J401 (SMA connector)

Note! Components under shield cans are sensitive to ESD and should be handled with appropriate measures.

11.5 System Requirements

The system requirements are:

- Personal Computer (PC) or unit compatible for RS232 communications.
- An unused serial port (COM1…. COM4) for communication between the developer's board and the PC.
- A second serial port may also be required for additional functionality.
- A terminal program such as HyperTerminal, Kermit, Procomm, etc…

11.6 GX-47/48 Family; Connection

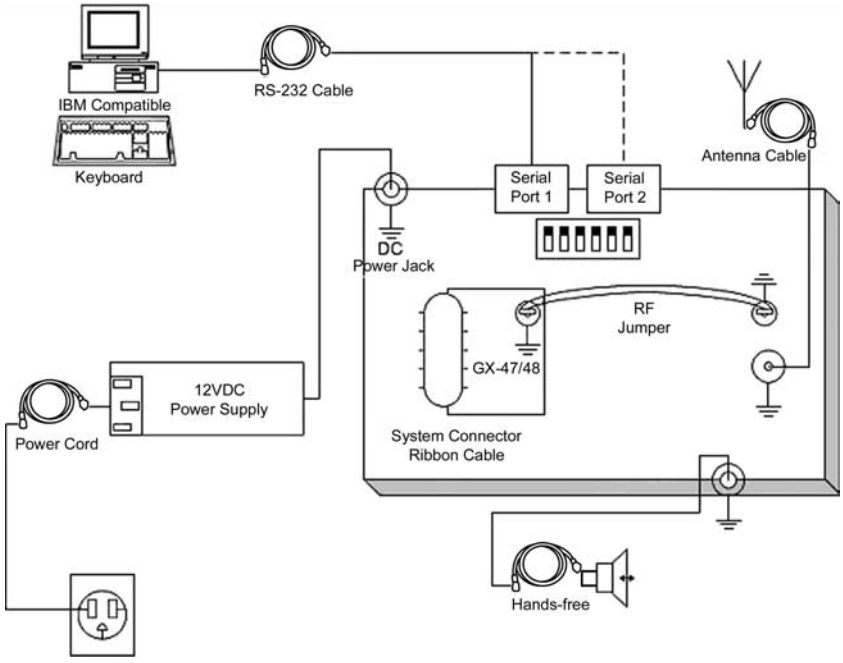

Figure 13.2 GX-47/48 Connection Diagram

- Connect serial cable from UDK board port 1 to an available serial port on the PC.
- The DC power supply provides the necessary 12VDC.
- Connect the power cable to the power supply and the AC outlet; select the appropriate line cord dependant on your location.
- Connect the output of the power supply to the power jack on the UDK board.
- Attach the provided antenna cable to the SMA antenna jack on the UDK board or directly to the primary RF output port of the module.

- For voice calls plug-in the provided Hands-free Speaker/Microphone.

12Using the Universal Developer's Kit

This section details the specific developer's board settings for the GM/GM 47R5/48 family. It is important that you verify these settings before powering up the developer's board and module.

The following configurations should be considered the baseline whenever attempting to resolve issues with the board or module. Note that HW flow control is turned on.

Caution! Ensure the Rotary Switch has been set to 4 prior to powering on the Developer's Board. Failure to do so may result in damage to the module.

12.1 Gx-47/48 Setup

Switch Settings:

Rotary Switch Setting (SW104)	*Audio Switch S201*	*Audio Switch S202*	*Flash Switch S101*
4	Bypass	Bypass	DCD

Table 2: Baseline Switch Settings for Gx-47/48

Jumper Settings:

X100	*X101*	*X102*	*X400*	*X501*	*X502*	*X503*	*TP101*
(Supply Source)	*(VDIG source select)*	*(Flash)*	*(SIM)*	*(TD)*	*(RD)*	*(Buzzer)*	*(Test Point)*
Internal	1-2	Normal	Installed	Sec Port	Sec Port	Installed	Installed

Table 3: Baseline Jumper Settings for Gx-47/48

X603	*X601*	*X401*	*X402*	*X403*	*X406*	*X407*
(PCM)	*(RTC)*	*(TO_IN)*	*(DTR_PWR_ON*	*(I^2C Address)*	*(I^2C Data)*	*(I^2C Clk)*
Internal	Installed	Installed	Installed	Uninstalled	Installed	Installed

Table 4: Baseline Jumper Settings for Gx-47/48

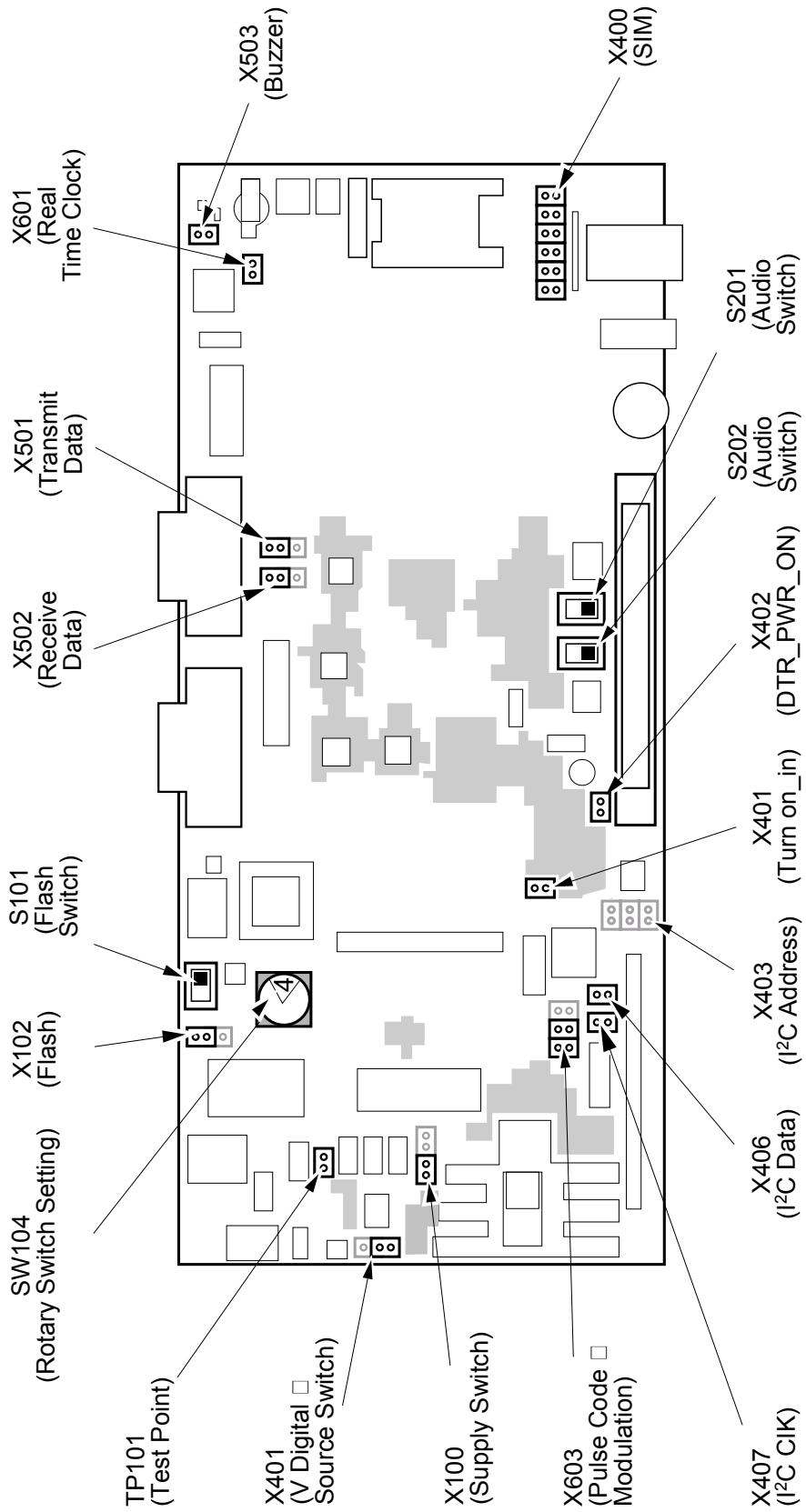

Figure 14.1 Switch and Jumper Settings

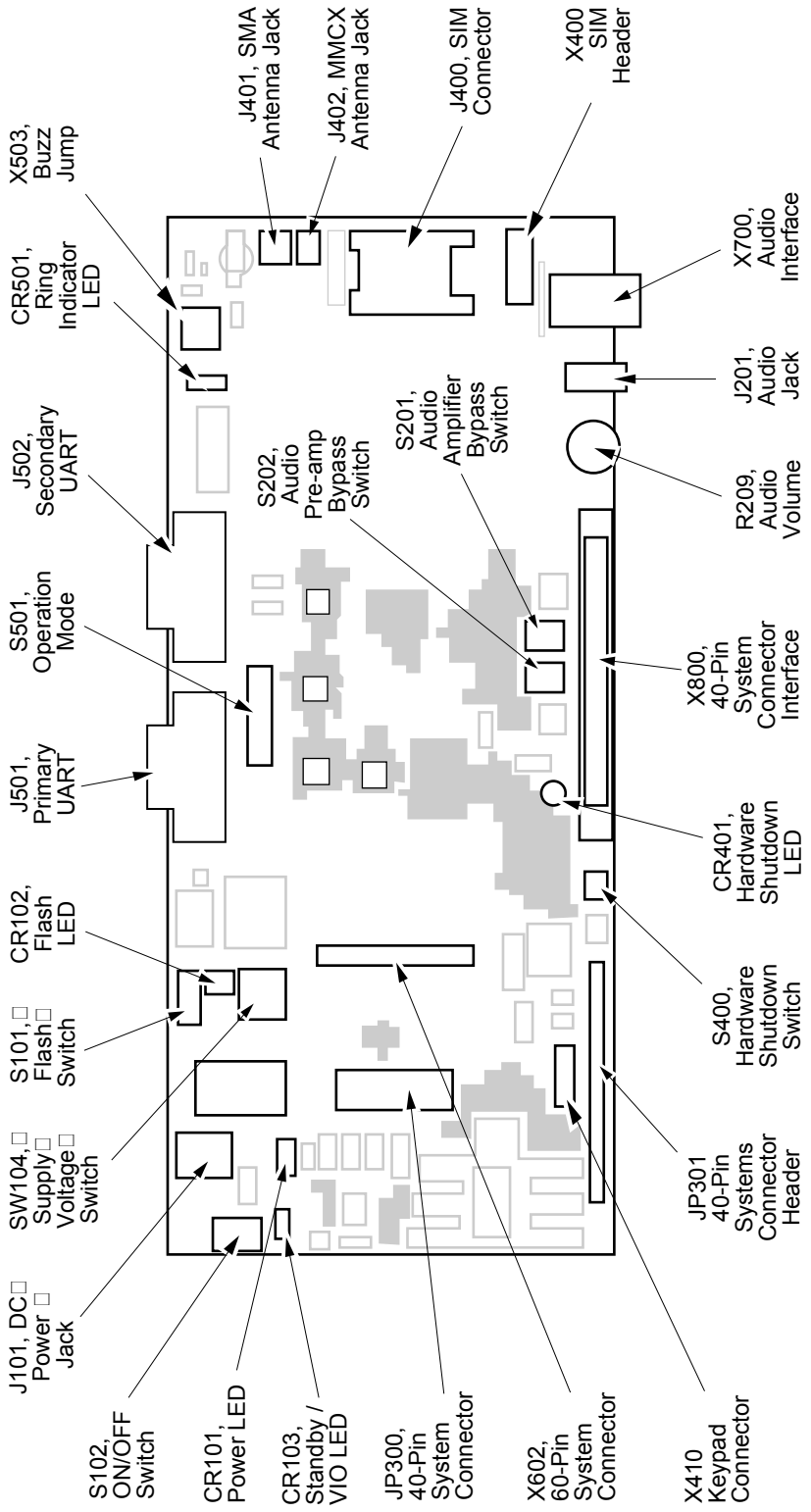

Figure 14.2 Switches, Indicators and Connectors

Operation Mode Settings:

Switch Position (S501)	*Function*	*ON/OFF*
Position 1	DTMS	ON
Position 2	CTS	ON
Position 3	DTR	ON
Position 4	DFMS	ON
Position 5	RTS	ON
Position 6	DSR	ON
Position 7	WAKE	ON

Table 5: Baseline Dip Settings for Gx-47/48

12.2 Operation Mode

Serial communication between the target module and the RS-232 level shifters is easily enabled / disabled via dip switches (S501). This allows testing of flow control (HW or None). This feature also allows the connection of your application's serial interface to the module while providing other connections, such as power, through the developer's board.

Switch	*Signal*	*ON*	*OFF*
Position 1	DTMS	Normal Operation	If External application is directly connected to System Connector Header
Position 2	CTS	HW Flow Control enable	If External application is directly connected to System Connector Header
Position 3	DTR	Normal Operation	If External application is directly connected to System Connector Header
Position 4	DFMS	Normal Operation	If External application is directly connected to System Connector Header
Position 5	RTS	HW Flow Control enable	If External application is directly connected to System Connector Header
Position 6	DSR	Normal Operation	If External application is directly connected to System Connector Header
Position 7	WAKE	Signal is grounded (Logic Low)	Signal is floating (Logic High)

Table 6: Description of Operation Mode Switch Settings

When switches 1 through 6 are in the OFF position, they are disconnected from the level shifters on the developer's board.

Hence the module determines the state of the signal at the System Connector Header. Refer to the appropriate Integrator's Manual for a description of the signals.

12.3 Serial interface

The external host communicates with the module/radio device through J501, which is a standard RS-232 9-pin interface (see below). The straight-through serial cable provided connects from J501 (DB-9 Female) to the serial port of a PC (DB-9 or DB-25 Female).

Pin	*RS-232*	*Description*
1	DCD	Data Carrier Detect
2	TXD	Transmission Data
3	RXD	Receiver Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request to Send
8	CTS	Clear to Send
9	RI	Ring Indicator

Table 7: RS-232 DB9 Pin-out

The primary connector, J501, routes all the signals to the module interface, while level shifting the appropriate ones. The secondary connector, J502, does not route all of the signals to the module. The following table details the signal routing from J502.

Pin	*RS-232*	*Routing*
1	DCD	Not Connected
2	TXD	to X502, Routes to CFMS (System Connector Pin 39) or TD3
3	RXD	to X501, Routes to CTMS (System Connector Pin 37) or RD3
4	DTR	Not Connected
5	GND	Ground
6	DSR	Not Connected
7	RTS	to J502 Pin 8 (CTS) through a 0 Ohm Resistor (R535)
8	CTS	to J502 Pin 7 (RTS) through a 0 Ohm Resistor (R535) and N502 Pin 17 through a 0 Ohm Resistor (R536)
9	RI	Not Connected

Table 8: RS-232 DB9 J502 Routing

Hardware Flow Control Mechanism is provided via the signals CTS, DTR and RTS. Flow control is used for CSD applications.

To activate or deactivate the Flow Control mechanism, switch S501 must be set as presented in Table 7 and Table 8 respectively.

Switch Position	*Function*	*DM-xx*	*CM-4x*	*GM-41*	*GM/GM*
Position 1	DTMS	ON	ON	ON	ON
Position 2	CTS	ON	ON	ON	ON
Position 3	DTR	ON	ON	ON	ON
Position 4	DFMS	ON	ON	ON	ON
Position 5	RTS	ON	ON	ON	ON
Position 6	DSR	ON	ON	ON	ON
Position 7	Module_Pwr_En_B		ON	ON	ON
	WAKE	OFF			

Table 9: S501 Settings to enable HW Flow Control

Switch Position	*Function*	*DM-xx*	*CM-4x*	*GM-41*	*GM/GM 47R5/48*
Position 1	DTMS	ON	ON	ON	ON
Position 2	CTS	OFF	OFF	OFF	OFF
Position 3	DTR	ON	ON	ON	ON
Position 4	DFMS	ON	ON	ON	ON
Position 5	RTS	OFF	OFF	OFF	OFF
Position 6	DSR	ON	ON	ON	ON
Position 7	Module_Pwr_En_B		ON	ON	ON
	WAKE	OFF			

Table 10: S501 Settings to disable HW Flow Control

If you intend to use the serial interface using the header connector (JP 301) provided on the developer's board, notice that appropriate CMOS voltage levels as defined by VDIG in §3.3 Power Interface shall be connected to the appropriate pins as follows:

Pin	*Signal*	*Description*	*Direction*
23	DCD	Data Carrier Detect	O
25	CTS	Clear To Send	O
26	DTR	Data Terminal Ready	I
27	TD	Serial Data To Module (DTMS)	I
28	RTS	Request To Send	I
30	RD	Serial Data From Module (DFMS)	O

Table 11: Direction of Serial Data Signals

If this type of interface is to be used, positions 1, 3, and 5 of S501 must be set to OFF to prevent damage to the RS-232 transceivers.

12.4 Engine Application Port - 40-Pin Connector (X600)

The system connector header is used when the application requires direct access to any particular pin available in the system interface of the module (i.e., digital audio pins). This applies to the Gx-47/48 modules.

Note! Special care shall be taken when using the header connector in order to prevent damage to the RS-232 transceivers. The following table shows how to set the switch S501 when using the Application Port.

Switch	*Position Function*	*ON/OFF*
Position 1	DTMS	OFF
Position 2	CTS	OFF
Position 3	DTR	OFF
Position 4	DFMS	OFF
Position 5	RTS	OFF
Position 6		OFF

Table 12: Switch Settings for S501 when using the Application Port

Pin	*Signal*	*Description*
1	VCC	Regulated supply voltage
2	VCC	Regulated supply voltage
3	DGND	Chassis Ground
4	DGND	Chassis Ground
5	ON/OFF	ON/OFF control of the radio device
6	TO_IN	Turn on in
7	HR_IN	Hardware Reset in
8	X606_1	Connection to Header X606 Pin 1
9	IO_1	General Purpose Binary Input / Output # 1
10	IO_2	General Purpose Binary Input / Output # 2
11	IO_3	General Purpose Binary Input / Output # 3
12	IO_4	General Purpose Binary Input / Output # 4
13	VIO	Input/Output Voltage Reference
14	DGND	Chassis Ground
15	IO_5	General Purpose Binary Input / Output # 5

16	ADC1	Output for A/D Converter #1
17	ADC2	Output for A/D Converter #2
18	ADC3	Output for A/D Converter #3
19	DAC	Input for D/A Converter
20	DGND	Chassis Ground
21	IO_6	General Purpose Binary Input / Output # 6
22	TX_ON	Transmit on
23	SDA	I^2C bus, data line
24	SCL	I^2C bus, clock line
25	DGND	Chassis Ground
26	X606_2	Connection to Header X606 Pin 2
27	DFMS	Data from Mobile Station
28	DTMS_C	Data to Mobile Station
29	RTS_M	Request to Send
30	CTS_M	Clear to Send
31	DSR_M	Data Set Ready
32	RI_M	Ring Indicator
33	DCD_SW	Data Carrier Detect
34	DTR_M	Data Terminal Ready
35	CTMS	Secondary Data to Mobile Station
36	CFMS	Secondary Data from Mobile Station
37	TD3	Transmit Data
38	RD3	Receive Data
39	X606_3	Connection to Header X606 Pin 3
40	X606_4	Connection to Header X606 Pin 4

Table 13: Pin-out of 40-Pin Application Port (X600)

12.5 RF Interface

A MMCX connector, J402, is provided on the Developer's board and routed to a SMA connector, J401. This allows a standard cellular antenna with SMA connector to be used if the module has a non-SMA connector mounted on it. An MMCX to MMCX RF Jumper is provided to connect from the module to J402.

12.6 Audio Interface

Analog audio is routed to/from the Developer Kit in two ways and is controlled by switches S201 and S202:

1 Via a 2.5mm stereo jack at J201 (S201 set to “Pre-Amp” and S202 is “ON”). Used with hands-free set.

2 Via ATMS and AFMS (S201 set to “Bypass” and S202 is “OFF”).

3 The Gx-47/48 platform does not require the external pre-amp. Set S201 to “Bypass” and S202 to “OFF”.

Analog audio is provided on pins 7 and 10 of the system connector header as presented below:

Pin	*Signal*	*Description*
7	AFMS	Audio Output From Module (referenced to AGND)
10	ATMS	Audio Input to Module (referenced to AGND)
9	AGND	Analog Reference

Digital audio is provided on pins 17, 18, 19 and 20 of the system connector header. The application must ensure providing the correct levels on the PCM signals according to the Digital Audio section of the appropriate Integrator's Manual. The PCM signals available in the system connector header are presented below:

Pin	*Signal*	*Description*
17	PCMCLK	PCM Clock Output from module.
18	PCMSYNC	PCM Frame Sync Output from module.
19	PCMULD	PCM Voice Input to module.
20	PCMDLD	PCM Voice Output from module.

12.7 Keypad Connector (X410)

A 10 pin connector is provided to connect directly to the Keypad options when they are selected by the AT command AT*E2IO.

Pin	*Signal*	*Description*
1	KEYCOL0	Keyboard column 1 (GND)
2	KEYROW1	Data Terminal Ready / Keyboard row 1 / General purpose
3	KEYCOL1	Data Carrier Detect / Keyboard column 1 / General purpose output 1
4	KEYROW2	General purpose input/output 1 / Keyboard row 2
5	KEYCOL2	Ring Indicator / Keyboard column 2 / General purpose output 2
6	KEYROW3	General purpose input/output 3 / Keyboard row 3
7	KEYCOL3	General purpose output 5 / Keyboard column 3 / Data Set Ready
8	KEYROW4	General purpose input/output 4 / Keyboard row 4
9	KEYCOL4	Clear To Send / Keyboard column 4 / General purpose output 4
10	N/C	Not connected

Table 14: Keyboard Connector X410

12.8 Flashing Firmware

The developer's board has the hardware circuitry to support firmware upgrading of several of the module families. Switch S101 when placed in the FLASH mode allows the module to re-flashed. Header X102 selects the Voltage used for Re-Flash

	DCD	*Flash*
S101	Normal Operation	FLASH Mode

	Normal (VDIG)	*FAST (12V)*
X102	1-2	2-3

12.9 Operation

Once the module has been mounted to the developer's board and all connections are made you are ready to power up the developer's board. Refer to Mounting a GX-47/48, page 66 for mounting information and a connection diagram.

Power On

To Power on the unit, ensure a 12VDC supply is connected to J101 and toggle the power switch S102. CR101 upper should illuminate. Press S400 and hold down for at least 0.5 seconds. CR103 upper should illuminate then about 4 seconds later CR103 lower will illuminate and a random character should appear in your terminal program (if connected to Serial port 1 and port settings are correct). Refer to GX-47/48 Family; Connection, page 67.

12.10 Flow Control

The developer's board has the ability to disable and enable the routing of HW flow control signals between the PC and the module. This is accomplished by setting S501 as per section 14.3.

Whenever communications difficulties arise with the module, disable HW flow control both on the developer's board and in your terminal program as a first step.

12.11 Power Down

When shutting down the developer's board and/or module it is important that the module is allowed to perform and orderly shutdown before power is removed. Do NOT simply pull the plug. Press S400 (the hardware shutdown button) and hold down for at least 1.5 seconds. Or send AT+CFUN=0. The radio device takes a few seconds to shut down properly. CR103 upper will stay illuminated until shutdown is complete.